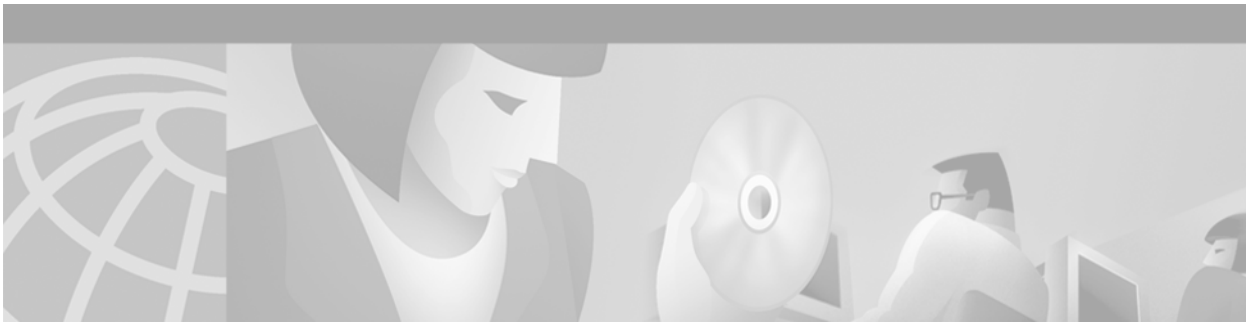


Configuring Headend Broadband Access Router Features

This chapter contains procedures for configuring the Cisco uBR7200 series universal broadband routers using the Cisco command-line interface (CLI). For detailed descriptions of the commands used, refer to the *Cisco IOS Multiservice Applications Command Reference* publication.

This chapter includes the following sections:

- Headend Overview
- Voice over IP Services
- Telco Return
- QoS Features
- Security Features
- Traffic Shaping Features
- Operations and Provisioning Features
- Spectrum Management
- Headend Broadband Access Router Configuration Prerequisites
- Headend Broadband Access Router Configuration Tasks
- Configuring the Downstream Cable Interface
- Configuring the Upstream Cable Interface
- Configuring and Activating Baseline Privacy
- Configuring and Activating Frequency Agility
- Activating IP Address Resolution Protocol
- Activating Host-to-Host Communication (Proxy ARP)
- Configuring DHCP Options
- Setting Service Options
- Setting Optional IP Parameters
- Configuring Cable Profiles
- Managing Cable Modems on the HFC Network
- Headend Broadband Access Router Configuration Examples
- Troubleshooting Using Cable Flap Lists

Headend Overview

a WAN backbone and a hybrid fiber-coaxial (HFC) cable network. Installed at a Community Antenna Television (CATV) head-end facility or distribution hub, the Cisco uBR7200 series is often located with the following Internet service provider (ISP)-related components:

- Ethernet switch
- Proxy servers
- WAN router
- Gatekeeper/gateway equipment for Voice over IP (VoIP) applications

The Ethernet switch is used to reduce traffic on the WAN backbone.

The proxy server usually functions as a Web cache for host computers and as the Dynamic Host Control Protocol/Trivial File Transfer Protocol (DHCP/TFTP) server for cable modems. DHCP for host computers in the HFC plant is often handled over the WAN. The WAN router provides a gateway to the data network.

For more information on these components and their requirements, refer to the "Supported System Configurations" section of the "Cisco uBR7200 Series Overview" chapter of the *Cisco uBR7200 Series Hardware Installation Guide*.

Note At the time of publication of this document, the Cisco uBR7200 series universal broadband routers use 6 MHz radio frequency (RF) channel plans only. However, Cisco IOS Release 12.1 T will support 8 MHz channel plans with the Cisco MC16E cable modem card.

On the RF side, the downstream port on the Cisco uBR7200 series router is assigned a 6 MHz channel slot at a standard broadcast CATV frequency. An upconverter device is used to convert the 44 MHz intermediate frequency (IF) output to the assigned slot. In North America, carrier frequencies in the forward plant are assigned from 54 MHz to 860 MHz. After upconversion, the signal is combined with other analog TV or digital TV signals and sent to the transmit input of a fiber transceiver.

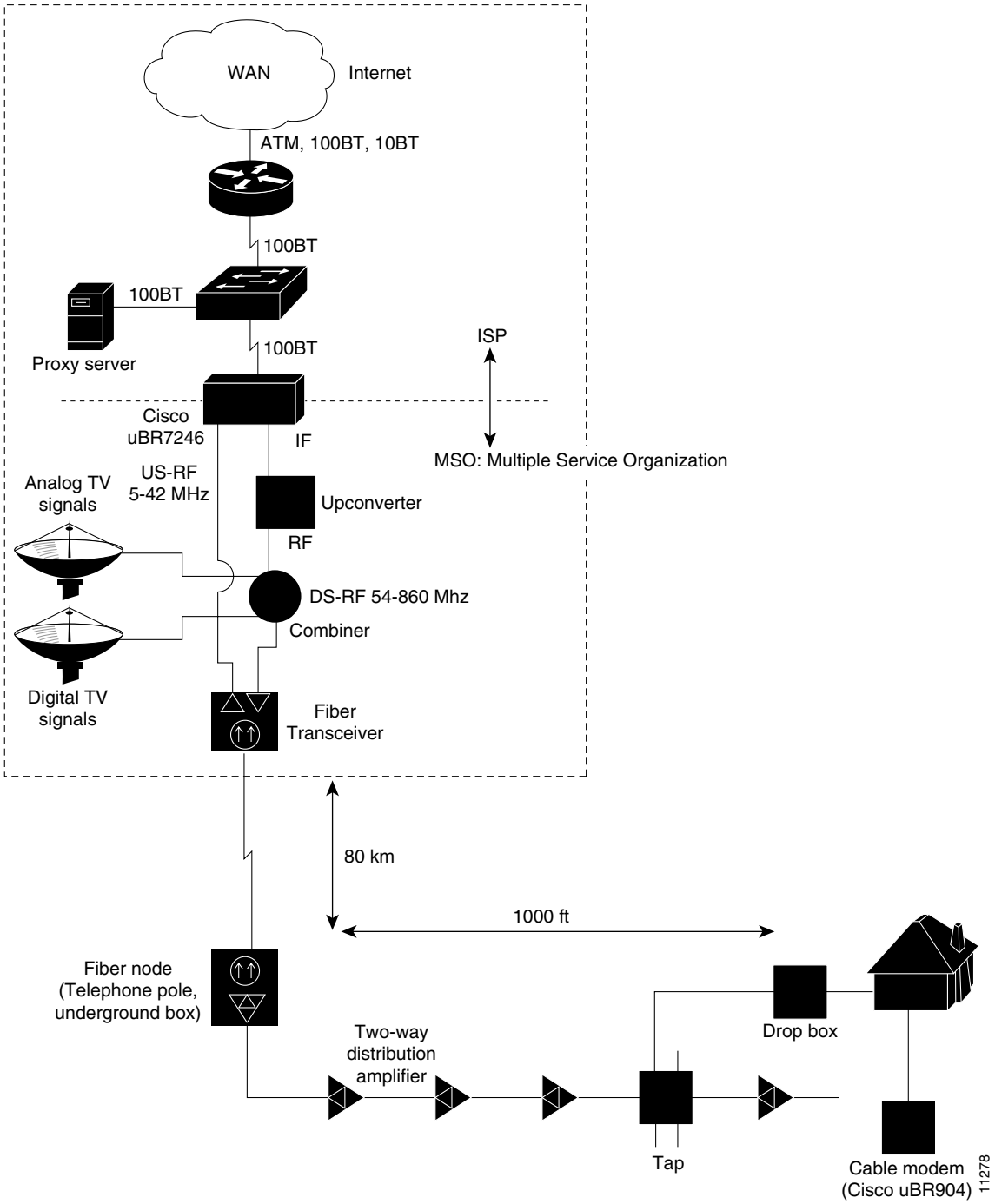
The receive input of the fiber transceiver is connected to an upstream port of the Cisco uBR7200 series router. The upstream port is assigned a 0.2 MHz to 3.2 MHz frequency band in the reverse plant. In North America, carrier frequencies in the reverse plant are between 5 MHz and 42 MHz.

The fiber transceiver is connected to up to 80 kilometers of optical fiber. Signals are carried in analog form to a neighborhood, where they terminate in a fiber node. The fiber node, located on a telephone pole or in an underground box, converts the optical signal back to an electrical signal, which is then passed on to a two-way distribution amplifier system. The distribution amplifier system passes through the neighborhood, where it is tapped off to individual CATV subscribers.

A coaxial cable delivers the signal from the tap to a drop box located on the subscriber premises. From the drop box, the signal is split and cabled to consumer CATV appliances. One cable goes to the television or set-top box; the other cable goes to a cable modem appliance such as a Cisco uBR900 series cable access router, providing data and IP telephony services.

Figure 106 illustrates the topology of a typical HFC network supporting basic data services.

Figure 106 Topology of a Typical Broadband Network



Cisco uBR7200 series routers support the DOCSIS 1.0 specifications (and static multiple service identifiers (SIDs) for voice) for the following high-speed data-over-cable interfaces:

- RF interfaces between the Cisco uBR7200 series (CMTS) and the cable network—Downstream and upstream traffic.
- MAC sublayer and associated interfaces.

- Data interfaces for cable modems and CPE devices, as well as the CMTS network-side interface between the Cisco uBR7200 series routers and the data network.
- Operations support interfaces—Network element management layer interfaces between the network elements and the operations support systems.
- Telco return interfaces—Interfaces between third-party DOCSIS-based cable modems and the telco return path(s) when the return path is not provided by the cable network.

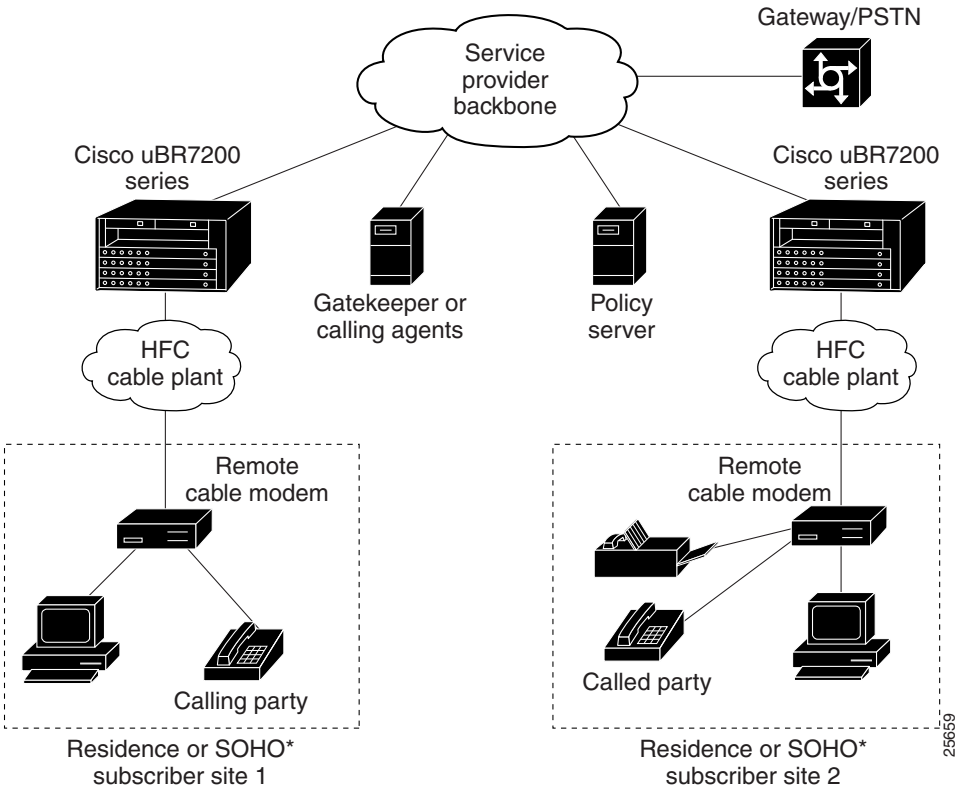
Cisco cable modem cards residing in the Cisco uBR7200 series routers provide the interface between the protocol control information (PCI) bus on the router and the RF signal on the HFC network. The subscriber-end cable modems and Cisco cable access routers are connected to the HFC network through upconverters and the Cisco cable modem cards.

The Cisco uBR7200 series routers support a variety of cable modem cards with different upstream and downstream transmission capabilities and features. You must install at least one Cisco cable modem card in the Cisco uBR7200 series chassis to establish communication between the Cisco uBR7200 series and the HFC network. For detailed information, refer to the *Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide*.

Voice over IP Services

Figure 107 shows a typical two-way configuration involving Voice over IP (VoIP) telephony services. The Cisco uBR7200 series supports the transmission of digitized voice and facsimile traffic over the cable and IP backbone network.

Figure 107 Two-Way IP Telephony Network Diagram



*Small Office Home Office

The Cisco uBR7200 series equipment and DOCSIS-based cable modems supporting IP telephony can be configured to treat VoIP and regular data traffic separately. The system can be configured to keep regular data on a default class of service, while using a higher priority for the VoIP traffic that originates on the VoIP ports of the cable modem.

When creating a configuration for remote cable modems, the Cisco uBR7200 series system administrator typically configures extra classes of service. These secondary classes of service are expected to be higher QoS classes that are used by higher priority traffic such as voice. These classes have a minimum upstream rate specified for the channel.

System administrators can associate unique packet flows with a unique SID. These images support multiple SIDs per cable modem.

Note The cable modem must also support these higher classes of service.

Telco Return

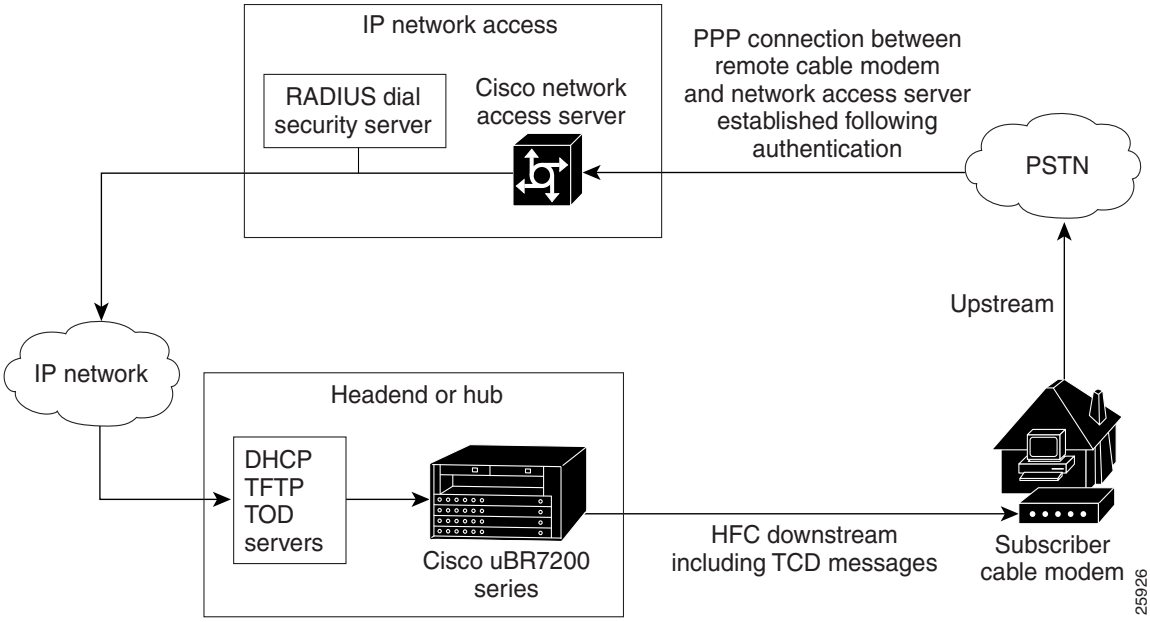
Cisco uBR7200 series routers can register third-party DOCSIS-based telco return cable modems based on the DOCSIS telco return specification. This feature enables the HFC network to support both two-way and telco return cable modems.

In telco return configurations, the Cisco uBR7200 series router provides downstream dataflow from cable modem cards connected to the cable system and accepts upstream traffic via a combination of the local public switched telephone network (PSTN) and IP network path that terminates at the

Cisco uBR7200 series input/output (I/O) controller or applicable port adapter. Upstream data is through a telephone modem typically connected to an analog telephone line. (The telephone modem can be external or internal to a cable modem, or a cable modem card in a PC, based on the third-party cable modem vendor.) Telco return gives cable companies that have not upgraded their cable plants or specific service areas to support two-way RF transmission the ability to offer fast downstream data services via the cable plant and upstream transmission via the PSTN.

Figure 108 illustrates a telco return application.

Figure 108 Telco Return Network Diagram



Downstream traffic must be precluded by Telephony Channel Descriptor (TCD) messages to enable upstream telco return traffic. TCD messages contain information necessary for the telco return cable modem to access the headend/ISP network access server (for example, a Cisco AS5300 or Cisco AS5800) over the PSTN.

TCD packets contain three critical telco return elements:

- Up to three dial telephone numbers for the telco return cable modem to use when attempting to connect to the headend network access server
- Username or MAC address information
- Authentication password(s)

When connected, the network access server feeds the subscriber username and password to a RADIUS dial security server. Access is granted or denied. When access has been attained, the network server sets up a PPP negotiation and connection.

QoS Features

The Cisco uBR7200 series universal broadband routers support QoS as defined by the DOCSIS 1.0 specification. Service class profiles can be configured through the Cisco CLI to support the QoS profile number, traffic priority, maximum upstream bandwidth, guaranteed upstream bandwidth, maximum downstream bandwidth, maximum transmit burst length, baseline privacy enable/disable, and type of service (ToS) overwrite byte.

The QoS Profile Enforcement feature allows you to control the QoS to eliminate any interference from improper local-rate limiting implemented on the cable modem. The CMTS provisions a registering cable modem with a default DOCSIS 1.0 service class assigned by the operator, overriding any service class that previously existed on the modem. This service class has no upstream or downstream rate limits so that the CMTS can do traffic shaping based on the QoS profile enforced by the operator.

As part of this functionality, Cisco uBR7200 series routers support multiple service classes per cable modem by providing multiple static QoS service identifiers (SIDs). The multiple SIDs feature allows the Cisco uBR7200 series CMTS to dynamically allocate and delete service flows for voice and fax transmissions.

These features are described in more detail in the following sections. For additional information on QoS, refer to the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Service Class Profiles

Cisco uBR7200 series routers allow you to create multiple service class profiles with the following characteristics:

- Traffic priority (7, 6, 5, 4, 3, 2, 1, 0) with 7 being the highest
- Maximum upstream rate in bits per second
- Maximum upstream channel burst in minislot
- Minimum upstream rate in bps
- Maximum downstream rate in bps

Using these service class profiles, you can define the following:

- A guaranteed-rate service queue to store bandwidth requests from cable modems subscribing to a class with minimum upstream rate on the upstream channel.
- A best-effort service queue to store bandwidth requests from cable modems subscribing to a class with no minimum upstream rate on the upstream channel.

  Both of these classes can be used to get an indication whether the grant server in MAPs is not serving bandwidth requests from cable modems subscribing to the particular service.

Note Most of the time, these queues will be empty because bandwidth requests get served immediately in MAPs.

Multiple Service IDs

The Cisco uBR7200 series routers allow you to statically define multiple service IDs (SIDs) on the upstream, enabling multiple service classes per cable modem. Multiple SIDs allow you to specify priority service flows higher than those specified in DOCSIS 1.0.

Multiple SIDs provide the following functionality:

- Voice traffic can be designated on a higher QoS committed information rate (CIR) secondary SID, while data traffic can be forwarded on a best-effort basis on a primary SID.
- Secondary SIDs are higher QoS CIR-type classes to be used for higher priority traffic such as voice. These classes have a nonzero minimum reserved rate (CIR-type service). Thus, these SIDs receive preferential treatment at the headend for grants over any tiered best effort type data SID for that upstream. Best-effort service involves requests with no minimum upstream rate on the channel.

  The CMTS treats the primary and secondary SIDs independently for issuing grants. Each SID of a cable modem has an independent state machine. Channel access for each SID is independent of the other SID.

Note Reliable operation with voice requires multiple SIDs—at least two per cable modem to separate voice from data traffic. In DOCSIS 1.0, SIDs are set up statically. In DOCSIS 1.1, SIDs can be set up either statically or dynamically.

QoS Profile Enforcement

QoS profile enforcement allows you to override the provisioned service class of a cable modem with a static CMTS-defined QoS profile. A static CMTS-defined QoS profile gives you control of the cable modem QoS and eliminates any interference from improper local-rate limiting implemented on the cable modem.

When this feature is enabled, the CMTS provisions each registering cable modem with a default DOCSIS 1.0 service class that is assigned by the CMTS operator. The operator-defined service class is enforced on cable modems attempting to register with the CMTS regardless of the provisioned class of service. The default service class has no upstream or downstream rate limits.

When the cable modem sends data upstream, it makes bandwidth requests without throttling or dropping packets because of its own rate-policing algorithm. The CMTS does traffic shaping based on the QoS profile enforced by the operator.

Note By default, the system will not enforce a specific QoS profile on the cable modem. The QoS profile assigned to the cable modem will depend on the class of service parameters provisioned in the DOCSIS configuration file.

TAG/NetFlow Switching

TAG switching and Netflow switching provide high performance for network layer services, enabling per-flow application of network services such as security and traffic accounting. The following data is collected for each flow:

- Source and destination IP address
- Start of flow and end of flow timestamps
- Packet and byte counts
- Next hop router address
- Input and output physical port interfaces

- Source and destination TCP/UDP port numbers
- IP protocol type
- Type of Service (ToS) field
- TCP flags
- Source and destination autonomous system numbers
- Source and destination subnet masks

Tag Switching

Tag switching is a Cisco-developed technology that implements a next-generation architecture for the Internet backbone and large intranets. Tags placed on the fronts of packets contain forwarding information used for making switching decisions and applying network services.

Tag switching has become the foundation for flexible Layer 3 virtual private networks (VPNs), QoS handling, and traffic engineering. It also forms the basis for the emerging Internet Engineering Task Force (IETF) standard for Multiprotocol Label Switching (MPLS).

A tag switching infrastructure combines with advanced routing protocol capabilities to define IP VPNs by selectively advertising IP reachability information to just those subscribers within the same VPN or extranet, thus keeping different VPN traffic logically separate. The subscribers are then all connected via tag switch paths (TSPs).

Forwarding is based entirely upon the assigned tag values (rather than IP destination prefixes), eliminating the requirement for uniqueness in the IP addresses that are used. This feature means subscribers to different VPNs need not concern themselves with the problems that would otherwise occur when connecting networks with different subnetworks into an integrated network.

Netflow Switching

NetFlow switching is a high-performance, network-layer switching path that provides network administrators with access to “call detail recording” information from their data networks; this information includes details such as user, protocol, port, ToS information, and the duration of the communication. This data can be used for a variety of purposes, including billing, enterprise accounting, network planning and performance analysis, QoS bandwidth management, security policies, and data warehousing/mining for marketing purposes.

The collected NetFlow data is sent out via UDP packets to a workstation running the Netflow Flowcollector server, which can collect data from multiple routers for later analysis by a user running the Netflow Flowanalyzer application. Through the NetFlow Data Export feature, traffic information can also be passed to external applications that perform functions such as billing or network performance analysis.

NetFlow also provides a highly efficient mechanism that can process security access lists without incurring the same performance penalty as other available switching methods. In conventional switching at the network layer, each incoming packet is handled on an individual basis with a series of functions to perform access list checks, capture accounting data, and switch the packet. In contrast, after NetFlow switching identifies a flow and processes the access list for the first packet of the flow, all subsequent packets are handled on a “connection-oriented” basis as part of the flow. This process avoids further access list checks on the flow, and packet switching and statistics capture are performed in tandem.

Weighted Random Early Detection

Weighted Random Early Detection (WRED) enables you to specify traffic handling policies to maximize throughput under congestion conditions. Random early detection (RED) works in conjunction with TCP to intelligently avoid network congestion. WRED combines IP precedence and RED capabilities to provide differentiated performance characteristics for different classes of service, thus providing preferential traffic handling for higher priority traffic. You can define minimum and maximum queue depth thresholds and drop probabilities for each class of service.

For more information on this feature, refer to the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Weighted Fair Queueing

Weighted Fair Queueing (WFQ) performs priority output queueing and custom queueing to grant resources to important sessions when network bandwidth is saturated; it is typically used for digitized voice packets to help reduce delay. WFQ provides expeditious handling for high priority traffic, requiring low delay, while fairly sharing the remaining bandwidth between lower priority traffic. WFQ divides link traffic into high and low priority flows based on metrics including IP precedence and traffic volume.

For more information on this feature, refer to the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Resource Reservation Protocol

Resource Reservation Protocol (RSVP) works in conjunction with WFQ; it helps the router establish a weight for different types of packets that affect the order in which the packets enter the output queue and are placed on the cable network for transmission. Voice packets are routed through the interface with a QoS method that allows the packets to receive priority over standard data frames. A router that supports RSVP gives priority to packets that fall into a reservation within RSVP.

For more information on this feature, refer to the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Committed Access Rate (CAR)

Committed Access Rate (CAR) provides the means to allocate and limit bandwidth to traffic sources and destinations, and specify policies to handle traffic exceeding the bandwidth allocation. CAR policies can be utilized at the ingress or egress of the network. CAR uses token bucket filters to measure traffic load and limit sources to bandwidth allocations.

Security Features

The following sections describe features that enhance the security of devices attached to the Cisco uBR7200 series cable access routers.

DOCSIS Baseline Privacy

The Cisco uBR7200 series routers support DOCSIS baseline privacy (BPI). When BPI is enabled, the Cisco uBR7200 series generates Traffic Encryption Keys (TEKs) for each applicable SID. The router uses the keys to encrypt downstream data and decrypt upstream traffic from two-way cable modems.

The Cisco uBR7200 series supports both 40-bit and 56-bit encryption/decryption. When BPI is enabled, 56-bit encryption/decryption is the default. A configuration command allows an administrator to manually force the Cisco uBR7200 series to generate a 40-bit DES key, where the DES key that is generated and returned masks the first 16 bits of the 56-bit key to 0 in software.

Note Both the Cisco uBR7200 series universal broadband router and the cable modem must contain software and be configured to support encryption/decryption.

The Cisco uBR7200 series router generates keys for unicast, broadcast, and multicast operation as appropriate. Keys are refreshed periodically and have a default lifetime of 12 hours.

Cable Modem and Multicast Authentication Using RADIUS

As an enhancement to baseline privacy, Cisco uBR7200 series universal broadband routers can be configured for cable modem and multicast authentication using the RADIUS protocol, an access server authentication, authorization, and accounting (AAA) protocol originally developed by Livingston, Inc. The Cisco uBR7200 series also supports additional vendor-proprietary RADIUS attributes.

When a cable modem comes online or when an access request is sent through a multicast data stream, the Cisco uBR7200 series sends relevant information to RADIUS servers for cable modem/host authentication. This feature can be configured on a per-interface basis.

An IETF draft standard, RFC 2138, defines the RADIUS protocol. RFC 2139 defines the corresponding RADIUS accounting protocol. Additional RFC drafts define vendor-proprietary attributes and MIBs that can be used with a Simple Network Management Protocol (SNMP) manager.

Upstream Address Verification

Upstream address verification prevents the spoofing of IP addresses by comparing the source IP address with the MAC address of the cable modem, thus verifying that each upstream data packet comes from the cable modem known to be associated with the source IP address in the packet. The **cable source-verify** [**dhcp**] cable interface command specifies that DHCP lease query requests are sent to verify any unknown source IP address found in upstream data packets. This feature requires a DHCP server that supports the LEASEQUERY message type.

Note Cisco Network Registrar (CNR) supports the LEASEQUERY message type in software release 3.01(T) and later.

Traffic Shaping Features

Traffic shaping is a Cisco patent-pending feature that conserves bandwidth by reducing the chances that information will be retransmitted to hosts on the HFC network. Traffic shaping in the upstream direction delays the scheduling of the upstream packet, causing the packet to be buffered on the cable CPE device instead of being dropped. Traffic shaping allows the TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the QoS levels defined for the subscriber.

Without traffic shaping, the Cisco uBR7200 series software drops bandwidth requests from cable modems that are found to have exceeded their configured peak upstream transmission rate. Dropping bandwidth requests (and eventually upstream packets) from a rate-exceeding cable modem causes TCP-related timeouts which cause the host sending the information to resend its information. Resent information wastes bandwidth on the network.

The Cisco uBR7200 series supports the following traffic shaping features:

- Downstream rate shaping—Allows downstream grants to rate-exceeding cable modems to be buffered without incurring TCP-related timeouts and retransmits.

  Downstream rate shaping enables you to partition downstream traffic for a cable modem into multiple classes of service and multiple data rates by using the three precedence bits in the ToS byte in the IP header to specify a class of service assignment for each packet. Those packets with the precedence bit set in the ToS field are given higher priority.

  Using the ToS byte, you can also calculate the data rate for a specified flow in addition to the data rate configured on a per-cable modem basis. By specifying a maximum data rate for a particular ToS, you can override the common maximum downstream data rate.

  Note Packets that contain ToS bytes that have not been configured for downstream data rates continue to use the common data rate limits.

- Upstream rate shaping—Allows upstream bandwidth requests from rate-exceeding cable modems to be buffered without incurring TCP-related timeouts and resends. This enables the CMTS to enforce the peak upstream rate for each cable modem without degrading overall TCP performance for the subscriber CPE devices. Upstream grant shaping is per cable modem (SID).

  Token bucket policing with shaping is the per-upstream default rate-limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

Operations and Provisioning Features

The following sections describe operational and provisioning features and enhancements of the Cisco uBR7200 series cable access routers.

Dynamic Ranging

The dynamic ranging feature is a Cisco patent-pending feature that supports quick restoration of service following a catastrophic plant failure. With dynamic ranging, hundreds of cable modems can come back online quickly. The time that the cable modems spend deferring contention ranging slots is minimized, significantly reducing cable modem reinitialization time.

Downstream Channel ID Configuration

Downstream channel ID configuration allows all cable modems on the HFC network to identify themselves via unique downstream channel IDs instead of their downstream frequencies. Cable modems communicate their downstream ID when making a connection, not their downstream frequency. This feature allows system administrators to enter a configurable downstream channel ID to a value other than the default. Thus, each downstream channel ID can be unique on a cable network.

Downstream Frequency Override

Cisco uBR7200 series routers are able to change the downstream frequency for any or all cable modems, overriding the DOCSIS configuration file settings.

CPE Limitation

Cisco uBR7200 series routers can report and limit the number of CPE devices per cable modem using CLI commands or SNMP.

Note This feature is separate from the ability of a cable modem to support multiple CPE devices. For example, depending on the Cisco IOS software release being used, Cisco uBR900 series cable access routers can support a maximum of either 3 or 254 CPE devices. Also, by default, a DOCSIS-based cable modem supports one CPE device, but this can be changed by modifying the MAX CPE parameter in the DOCSIS configuration file.

Burst Profile Configuration

For each modulation/burst profile configuration, Cisco uBR7200 series universal broadband routers will support burst profile number, burst profile interval usage code, burst type, preamble length and unique word length, differential encoding enable/disable, forward error correction (FEC) correctable bytes value, FEC code word length, scrambler seed value, maximum burst size, guard time size, last code word shortened/lengthened, and scrambler enable/disable.

Note Multiple burst profiles are supported on the MC11C, MC12C, MC14C, MC16B, and MC16C cable modem cards. Only one profile is supported on the original MC11-FPGA card.

Cable Modem and Host Subnet Addressing

The Cisco uBR7200 series cable access routers can manipulate the GIADDR field of DHCPDISCOVER and DHCPREQUEST packets with a Relay IP address before they are forwarded to the DHCP server.

By modifying the GIADDR field based on whether the source is a cable modem or a host, the Cisco uBR7200 series provides hints to the DHCP server as to where (that is, on which IP subnet) the server should allocate addresses to the requesting client.

Per-Modem and per-Host Access Lists

Per-modem and per-host access lists allow Cisco uBR7200 series routers to filter incoming packets from individual hosts or cable modems based on the source MAC or IP address. Access lists can thus be specified on a per-interface or a per-address basis. The packets received from cable modems or individual hosts are filtered based on the cable modem or host from which the packets are received.

You can preconfigure the filters by using the CLI following standard Cisco IOS access list and access group configuration procedures. You can assign these filters to a user or modem by using the CLI or SNMP.

This feature also supports traps to inform the CMTS about the online/offline status of modems.

Basic Wiretap Support

Cisco uBR7200 series routers provide support for a basic wiretap facility for VoIP calls, as required by the United States Federal Communications Assistance for Law Enforcement Act (CALEA). The wiretap facility is based on the MAC address of the cable modem, so it can be used for either data or digitized voice connections.

The feature is controlled by the **cable intercept** command, which requires a MAC address, an IP address, and a UDP port number as its parameters. When activated, the Cisco uBR7200 series universal broadband router examines each packet for the desired MAC address; when a matching MAC address is found (for either the origination or destination endpoint), a copy of the packet is encapsulated into a UDP packet, which is then sent to the specified server at the given IP address and port.

Inter-Switch Link Bridging on Noncable Interfaces

Inter-Switch Link (ISL) is a Cisco protocol used to interconnect multiple routers and switches and maintain virtual LAN (VLAN) information as traffic passes between routers and switches.

Integrated Time-of-Day Server

Cisco uBR7200 series routers are able to obtain the correct time-of-day (ToD) and respond to (RFC 868) queries from cable modems during the registration process.

Integrated DHCP Server

Cisco uBR7200 series routers offer an integrated DHCP server to simplify the provisioning of cable modems.

Spectrum Management

Due to the nature of CATV technology, upstream noise management is a significant issue. Frequency bands must have a sufficient carrier-to-noise ratio (CNR) and carrier-to-ingress power ratio to support the transmission of quadrature phase-shift keying (QPSK) and quadrature amplitude modulation (QAM)

data. The DOCSIS specification sets the minimum value for both of these parameters to 25 dB in the 5-MHz to 42-MHz frequency range. If the CNR drops below this value on a particular channel due to noise, the cable modem on that channel will drop off of the HFC network.

We recommend that system administrators use upstream frequency hopping as a countermeasure to long-term narrowband noise. To provide this capability, Cisco uBR7200 series routers contain a spectrum manager that continuously monitors the noise in unused upstream channels. If the CNR reaches an unacceptable level on a particular channel, the spectrum manager will automatically assign a new upstream channel to the cable modem using that channel. This is referred to as frequency agility.

Cisco uBR7200 series routers support the following techniques for upstream frequency hopping when no clean frequency band is available:

- Blind frequency hopping—The spectrum manager automatically assigns a new upstream channel frequency when station maintenance (keepalive) messages fail for approximately 2.5 minutes. This represents a complete impairment of the upstream due to noise, plant, or equipment failure.
- Time scheduled frequency hopping—Frequency reassignment is based on the time of day or week.
- Combined blind and time scheduled reassignment.
- Guided frequency hopping—Explicit frequency subbands and associated input power levels are assigned in a spectrum group.

Note Frequency hopping is not effective against broadband noise phenomena such as impulse noise.

The Cisco uBR7200 series allows you to create up to 32 cable spectrum groups, each containing multiple upstream ports. The configured channel width is used for each upstream. In addition, the router maintains a flap list containing the MAC address for each cable modem having problems maintaining its connection. (A “flapping modem” is a cable modem that rapidly disconnects and reconnects to the CMTS.)

Note Because spectrum management capabilities focus on the upstream path over an HFC network, this feature is not applicable to one-way (telco return) systems.

Headend Broadband Access Router Configuration Prerequisites

Before you can configure Cisco uBR7200 series universal broadband router features, you must first perform the following tasks:

- Make sure that your current network is designed to support broadband transmission. At the very least, your network must include the following:
  - Computer on the WAN side of your Cisco uBR7200 series configured as a DHCP server to assign IP addresses to cable modems on the HFC network.
  - Cisco uBR7200 series-compatible IF-to-RF upconverter installed in the downstream data path at your headend site. The upconverter is installed between the Cisco uBR7200 series and the combiner.

Note The combiner refers to all cables, amplifiers, and taps at the headend or cable distribution center that connect the Cisco uBR7200 series to the HFC network.

  - Diplex filters installed in the downstream RF path between the cable modems and the cable modem cards in the Cisco uBR7200 series. Diplex filters are used to convert the single, bidirectional signals used by cable modems to the two separate unidirectional signals used by the cable modem cards.
  - RG-59 headend coaxial cable with the maximum braid available (60 percent + 40 percent braid), double foil, and the correct connector for this cable. The center conductor must be straight and extend 1/8 inch (3.2 mm) beyond the end of the connector. The connector should be securely crimped to the cable.

- Complete a basic configuration of the Cisco uBR7200 series. This includes, as a minimum, the following tasks:
  - Configure a host name and password for the Cisco uBR7200 series. For more information about how to configure a host name and password, refer to the *Cisco uBR7200 Series Installation and Configuration Guide*.
  - Configure the Cisco uBR7200 series to support IP. For more information about how to configure IP, refer to the "IP Overview," "IP Addressing and Services," and "IP Routing Protocols" chapters in the *Cisco IOS IP and IP Routing Configuration Guide*.
  - Install and configure at least one port adapter to provide WAN connectivity. The Cisco uBR7200 series supports the following port adapters: 4-port 10Base-T Ethernet, 8-port 10Base-T Ethernet, 100Base-T Fast Ethernet, ATM, and HSSI.

    For information about installing and configuring port adapters, refer to the installation and configuration guide for the port adapter(s) you are using.
- Install at least one Cisco cable modem card in the appropriate slot of Cisco uBR7200 series chassis. For information about installing the Cisco cable modem card, refer to the *Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide*.

Headend Broadband Access Router Configuration Tasks

The Cisco IOS software CLI is used to configure the Cisco cable modem card for correct operation on the HFC network. To configure the Cisco cable modem card, perform the tasks described in the following sections. For some tasks, the default values are adequate to configure the device; these configuration tasks are optional.

- Configuring the Downstream Cable Interface
- Configuring the Upstream Cable Interface
- Configuring and Activating Baseline Privacy (Optional)
- Configuring and Activating Frequency Agility (Optional)
- Activating IP Address Resolution Protocol (Optional)
- Activating Host-to-Host Communication (Proxy ARP) (Optional)
- Configuring DHCP Options
- Setting Service Options
- Setting Optional IP Parameters (Optional)
- Configuring Cable Profiles (Optional)
- Managing Cable Modems on the HFC Network (Optional)

Configuring the Downstream Cable Interface

The first step in configuring the Cisco cable modem interface is to configure the downstream cable interface. The downstream direction refers to the data flow from the Cisco cable modem card in a Cisco uBR7200 series to the subscriber's cable modem. Data passing through the Cisco cable modem card is converted to IF and then passed through an upconverter to transform the signal to RF. This RF signal is then sent down the line to the subscriber's cable modem. Downstream cable interface commands configure the frequency, symbol rate, compression, and modulation of the downstream signal.

To configure the downstream cable interface, perform the following tasks:

- Activating the Downstream Carrier
- Setting the Downstream Center Frequency
- Setting the Downstream Channel ID
- Setting the Downstream MPEG Framing Format (Annex B)
- Setting the Downstream Modulation
- Setting the Downstream Interleave Depth
- Setting the Downstream Helper Address
- Setting Downstream Rate Limiting

Note In most applications, the default values for the commands used in these configuration steps are adequate to configure the Cisco uBR7200 series router.

Activating the Downstream Carrier

To activate a downstream port on a Cisco uBR7200 series cable modem card for digital data transmissions over the HFC network, use the following commands:

	Command	Purpose

Step 1	`CMTS01> enable`
	`Password: <password>`
	`CMTS01#`
		Enters enable (privileged EXEC) mode.
		Enters the password.
		You have entered privileged EXEC mode when the prompt displays the pound symbol (`#`).

Step 2	`CMTS01# configure terminal`
	`Enter configuration commands, one per line. End with CNTL/Z.`
	`CMTS01(config)#`
		Enters global configuration mode. You have entered global configuration mode when the prompt displays `(config)#`.
		This command can be abbreviated to **config t**.

Step 3	`CMTS01(config)# interface cable 6/0` `CMTS01(config-if)#`	Enters cable interface configuration mode. In this example, the interface is downstream port 0 on the cable modem card installed in slot 6 of the Cisco uBR7200 series.

	Command	Purpose
Step 4	`CMTS01(config-if)# cable downstream if-output` or `CMTS01(config-ikf)# no cable downstream if-output`	Default. Activates downstream digital data from the Cisco uBR7200 series. Deactivates downstream digital data. This command mutes the IF output of the cable modem line card and shuts down the interfaces.
Step 5	`CMTS01(config-if)# no shutdown`	Places the downstream port in the "admin up" state.
Step 6	`CMTS01(config-if)# end CMTS01# %SYS-5-CONFIG_I: Configured from console by console`	Returns to privileged EXEC mode. This message is normal and does not indicate an error.

Verifying the Downstream Carrier

To verify whether the downstream carrier is active (up), enter the **show controllers cable** command for the downstream port that you just configured:

```
CMTS01# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem line card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.

Setting the Downstream Center Frequency

Downstream frequency is an information-only parameter that must match the digital carrier frequency, which is the center frequency of the downstream RF carrier (the channel) for a particular downstream port. The configuration controlling the digital carrier frequency is performed in the IF-to-RF upconverter that must be installed in the downstream path from the Cisco uBR7200 series. Refer to the documentation for your upconverter for information about configuring the upconverter.

Enter the fixed center frequency of the downstream RF carrier for the downstream port. You can also select a default that does not set a specific fixed value. The valid range for a fixed center frequency is 54,000,000 to 1,020,000,000 Hz.

The digital carrier frequency is specified to be the center of a 6.0 MHz channel. For example, EIA channel 95 spans 90.000 to 96.000 MHz. The center frequency is 93.000 MHz, which is the digital carrier frequency that should be configured as the downstream frequency. The typical range for current CATV headends is 88,000,000 to 860,000,000 Hz. The DOCSIS specification is 91,000,000 to 857,000,000 Hz:

- The channels must be centered on a National Television Systems Committee (NTSC) EIA channel plan for most DOCSIS cable modems to rapidly acquire the downstream frequency.

- Although some DOCSIS cable modems will search on 250 kHz step size, use of non-NTSC channel plans could significantly increase the cable modem installation time.

Note The digital carrier frequency is not the same as the video carrier frequency. For EIA channel 95, the video carrier frequency is 91.250 MHz, which is 1.75 MHz below the center frequency.

Note This command currently has no effect on external upconverters; it is informational only.

To set the downstream center frequency, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)#` **`cable downstream frequency`** *`down-freq-hz`*	Sets the fixed center frequency for your downstream RF carrier in Hz.

Verifying the Downstream Center Frequency

To verify the current value of the center frequency, enter the **show controllers cable** command for the downstream port that you have just configured.

- If the center frequency is fixed, the actual frequency will be displayed:

```
router# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
  Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
  FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

- If the center frequency is not fixed, the frequency will show that it is not set:

```
router# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
  Frequency is not set. Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
  FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you have calculated and entered the center frequency for your headend accurately.

Setting the Downstream Channel ID

To assign a numeric channel ID to the downstream port on the Cisco cable modem card, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable downstream channel-id id`	Specifies the downstream channel ID. Acceptable range is 0 to 255.

Verifying the Downstream Channel ID

To verify the downstream channel ID, enter the **show controllers cable** command for the downstream port you have just configured:

```
CMTS01# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure the downstream carrier is active by entering the **cable downstream if-output** command.

Setting the Downstream MPEG Framing Format (Annex B)

The Moving Pictures Experts Group (MPEG) framing format must be compatible with your local standards and specifications for downstream MPEG framing. Annex B is the DOCSIS MPEG framing format standard for North America; Annex A is the European standard.

In Cisco IOS Release 12.1, only the Annex B MPEG framing format is supported.

Note The cable modem card downstream ports and the cable modems on the HFC network connected through these ports must be set to the same MPEG framing format.

To set the downstream MPEG framing format, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable downstream annex B`	Sets the downstream MPEG framing format.

Verifying the Downstream MPEG Framing Format

To verify the downstream MPEG framing format setting, enter the **show controllers cable** command for the downstream port you have just configured:

```
router# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure the downstream carrier is active by entering the **cable downstream if-output** command.

Setting the Downstream Modulation

By setting the downstream modulation, you define the speed in symbols per second at which data travels downstream to the subscriber cable modem. A symbol is the basic unit of modulation. QPSK encodes 2 bits per symbol, 16-QAM encodes 4 bits per symbol, 64-QAM encodes 6 bits per symbol, and 256-QAM encodes 8 bits per symbol.

The valid modulation rates for a downstream port on a Cisco cable modem card are 64 QAM (6 bits per downstream symbol rate) and 256 QAM (8 bits per downstream symbol rate).

Note Setting a downstream modulation rate of 256-QAM requires approximately a 6 dB higher signal-to-noise ratio (SNR) than 64-QAM at the subscriber cable modem. If your network is marginal or unreliable at 256-QAM, use the 64-QAM format instead.

To set the downstream modulation, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable downstream modulation 64qam`	Sets the downstream modulation. The standard DOCSIS modulation rate (and the Cisco default) is 64qam.

Verifying the Downstream Modulation

To verify the downstream modulation setting, enter the **show controllers cable** command for the downstream port you have just configured:

```
router# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you have selected the default if you are not certain about the modulation rate needed.
- Make sure the downstream carrier is active by entering the **cable downstream if-output** command.

Setting the Downstream Interleave Depth

Set the interleave depth for the downstream port on the Cisco cable modem card. A higher interleave depth provides more protection from bursts of noise on the HFC network; however, it will increase downstream latency. The valid values are 8, 16, 32 (default), 64, and 128.

To set the downstream interleave depth, use the following command in cable interface configuration mode:

Command	Purpose
CMTS01(config-if)# **cable downstream interleave-depth** {**8**|**16**|**32**|**64**|**128**}	Sets the downstream interleave depth in milliseconds.

Verifying the Downstream Interleave Depth

To verify the downstream interleave depth setting, enter the **show controllers cable** command for the downstream port you have just configured:

```
router# show controllers cable 6/0 downstream
Cable6/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure the downstream carrier is active by entering the **cable downstream if-output** command.

Setting the Downstream Helper Address

Specify an IP address of a DHCP server where UDP broadcast (DHCP) packets will be sent. You can specify a DHCP server for UDP broadcast packets from cable modems and a DHCP server for UDP broadcast packets from hosts.

To set a downstream helper address, use one of the following commands in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable helper-address 10.x.x.x cable-modem`	Sets the downstream helper address to the DHCP server at IP address 10.x.x.x for UDP broadcast packets from cable modems. **Note** Use the IP address of the DHCP server. Both 10.x.x.x and 172.56.x.x are private ranges.
Step 2	`CMTS01(config-if)# cable helper-address 172.56.x.x host`	Sets the downstream helper address to the DHCP server at IP address 172.56.x.x for UDP broadcast packets from hosts.

Verifying the Downstream Helper Address

To verify the downstream helper address setting, enter the **show running-config** command and look for `ip helper-address` in the cable interface configuration information:

```
CMTS01# show running-config
Building configuration...

Current configuration:
!
interface Cable4/0
 ip address 10.254.254.254 255.0.0.0
 no ip directed-broadcast
 ip helper-address 192.168.1.1
 no keepalive
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- If the cable modems do not find a downstream: check the cables, upconverters, RF levels, and frequencies.
- If the cable modems find a downstream but not an upstream: check the cables, RF levels, and upstream frequencies, and enter the **no shut** command.
- If the cable modems acquire an RF upstream and downstream lock, but do not stay up: check the provisioning servers; ping the DHCP server using the source IP address option (the primary IP address of a cable interface); check IP routing.

- If the cable modems acquire an RF and a DHCP, but fail on TOD or TFTP: check DHCP options and the IP address of the TOD server; ping the TOD server using the source IP address option (the primary IP address of a cable interface); check IP routing; verify that the TFTP filename is correct, the TFTP file is in the correct directory on the TFTP server, and that the TFTP file has read privileges for all; ping the TFTP server using the source IP address option (the primary IP address of a cable interface); check IP routing, and so on.

Setting Downstream Rate Limiting

Downstream rate limiting enables you to use the token bucket policing algorithm with traffic shaping options or the weighted discard policing algorithm to buffer, shape, or discard packets that exceed a set bandwidth. Downstream rate limiting is disabled by default.

To enable downstream rate limiting for a downstream port on a Cisco cable modem card, use one of the following commands in cable interface configuration mode:

	Command	Purpose

Step 1	`CMTS01(config-if)# cable downstream rate-limit token-bucket`
	
	or
	
	`CMTS01(config-if)# cable downstream rate-limit token-bucket shaping`
	
	or
	
	`CMTS01(config-if)# cable downstream rate-limit token-bucket shaping granularity 8`
	
	or
	
	`CMTS01(config-if)# cable downstream rate-limit token-bucket shaping max-delay 256`
		Enables rate limiting on the downstream port using the token bucket policing algorithm. With this command, the Cisco uBR7200 series will automatically drop packets in violation of the allowable bandwidth.
		
		Enables rate limiting on the downstream port using the token bucket policing algorithm with traffic shaping.
		
		Enables rate limiting on the downstream port using the token bucket policing algorithm with specific traffic shaping time granularity. Acceptable values are 1, 2, 4, 8, or 16 milliseconds (ms).
		
		Enables rate limiting on the downstream port using the token bucket policing algorithm with specific maximum traffic shaping buffering delay. Acceptable values are 128, 256, 512, or 1028 ms.

Step 2	`CMTS01(config-if)# cable downstream rate-limit weighted-discard 3`	Enables rate limiting on the downstream port using the weighted packet discard policing algorithm and assign a weight for exponential moving average of loss rate. Acceptable values are 1 to 4.
Step 3	`CMTS01(config-if)# ^ZCMTS01#`	Exits to EXEC mode so that you can verify the steps.

Verifying Downstream Rate Limiting

To verify whether or not downstream rate limiting has been configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If downstream rate limiting has been configured and enabled, a rate limiting entry will be displayed in the output; if downstream rate limiting is disabled, no rate limiting entry will be displayed.

```
CMTS01# show running-config
Building configuration...

Current configuration:
!
interface Cable4/0
 ip address 10.254.254.254 255.0.0.0
 no ip directed-broadcast
 ip helper-address 192.168.1.1
 no keepalive
 cable downstream rate-limit token-bucket shaping
 cable downstream annex B
 cable downstream modulation 64qam
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you selected the default if you are not certain about the modulation rate needed.
- Make sure the downstream carrier is active by entering the **cable downstream if-output** command.

Configuring the Upstream Cable Interface

The upstream direction refers to the data flow from a subscriber cable modem to the cable modem card in a Cisco uBR7200 series router. The subscriber cable modem sends an RF signal back to the Cisco cable modem card, which translates the RF signal back to data format. Upstream cable interface commands configure the frequency and input power level of the upstream signal, in addition to error detection and correction of the upstream signal.

The configuration of the upstream cable interface depends on the characteristics of the cable operator's physical plant.

To configure the upstream cable interface, perform the following tasks:

- Setting the Upstream Frequency
- Setting the Upstream Channel Width
- Setting the Upstream Input Power Level
- Activating Upstream Admission Control
- Activating Upstream FEC
- Specifying Upstream Minislot Size
- Activating the Upstream Scrambler

- Activating Upstream Differential Encoding
- Activating Upstream Rate Limiting
- Activating Upstream Frequency Adjustment
- Activating Upstream Power Adjustment
- Activating Upstream Timing Adjustment
- Activating the Upstream Ports
- Setting Upstream Backoff Values

Setting the Upstream Frequency

The upstream channel frequency of your RF output must be set to comply with the expected input frequency of your Cisco cable modem card. To configure upstream channel frequencies, you may configure a fixed frequency of 5 to 42 MHz and enable the upstream port, or create a global spectrum group, assign the interface to it, and enable the upstream port.

You can also select a default that does not set a specific fixed value.

Note Some cable systems cannot reliably transport frequencies near the edges of the 5 to 42 MHz band. The wider the upstream channel (in MHz), the more difficulty you could have. Enter a center frequency of 20 to 38 MHz if you are having difficulty.

The cable modem card receiver accepts time-division multiplexed burst transmissions from cable modems that are DOCSIS compliant. The upstream port becomes "up" when it is assigned an upstream frequency and is configured to be administratively up.

The upstream port is frequency-agile. The frequency can change while the interface is up and carrying traffic, if you define spectrum groups. See the "Configuring and Activating Frequency Agility" section later in this chapter for details.

Upstream burst parameters can be configured by defining individual modulation profiles. A modulation profile consists of a table of physical layer characteristics for the different types of upstream bursts; for example, initial maintenance, long grant, request/data, request, short grant, and station maintenance.

Note The upstream cable interface will not operate until you either set a fixed upstream frequency or create and configure a spectrum group. See the "Configuring and Activating Frequency Agility" later in this chapter for details.

If you are setting a fixed upstream frequency, make sure that the frequency selected does not interfere with the frequencies used for any other upstream applications running in the cable plant.

Note If you are using the first version of the MC11 cable modem card, you cannot define an alternative upstream modulation profile.

To set a fixed upstream frequency, use the following commands in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable upstream` *usport* `frequency` *up-freq-hz*	Sets a fixed upstream frequency when you enter the fixed center frequency for your upstream RF carrier in Hz. Valid range for *usport* is from 0 to 5 if you are using the MC16 cable modem card.
Step 2	`CMTS01(config-if)# no cable upstream` *usport* +	Places the upstream port in the "admin up" state.

To configure the default upstream frequency (which is no fixed frequency), enter the **cable upstream** *usport* **frequency** command without specifying a center frequency.

Verifying the Upstream Frequency

To verify the current value of the upstream frequency, enter the **show controllers cable** command for the upstream port you have just configured:

```
CMTS01# show controllers cable 6/0 u0
Cable6/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Note The upstream frequency displayed in the **show controllers cable** command output might not match the frequency that you entered when you set the upstream frequency. The Cisco uBR7200 series might select an upstream frequency close to the frequency you entered that offers better performance. The minimum upstream frequency step size on the MC16C is 32 kHz. The Cisco uBR7200 series selects the closest frequency available.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem cards, this can be u0 to u3.
  - On the MC12C cable modem cards, this can be u0 or u1.
  - On the MC11C cable modem cards, this can be u0 only.
- Make sure you selected a valid frequency for your headend.

Setting the Upstream Channel Width

Enter the channel width in Hz. Valid values are 200000 Hz (160 kilosymbols per second, or ksps), 400000 Hz (320 ksps), 800000 Hz (640 ksps), 1600000 Hz (1280 ksps), and 3200000 Hz (2560 ksps). The default is 1600000 Hz.

Note If you change the channel width, the symbol rate changes accordingly (symbol rate = 1.25 * channel width). Higher symbol rates are more susceptible to RF noise and interference. If you use a symbol rate or modulation format beyond the capabilities of your HFC network, you might experience packet loss or loss of cable modem connectivity.

Note For QAM-16 channel widths of 400 kHz (320 ksps) or greater, we recommend that you use 16-QAM modulation only for long and short data and that you use QPSK for request, initial, and station communication. For QAM-16 channel widths of 200 kHz (160 ksps), all communication must be able to use 16-QAM. That is, 160 ksps with 16-QAM requires an *exceptional* SNR in your upstream channel(s). When you use QAM-16 for request, initial, and station maintenance messages with channel widths greater than 400 kHz, the QAM-16 preamble and message data takes longer to transmit than the QPSK format.

To set the upstream channel width, use the following command in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable upstream` *usport* `channel-width` *width*	Sets the upstream channel width for your upstream RF carrier in Hz.
Step 2	`CMTS01(config-if)# no cable upstream` *usport* `channel-width`	Returns the channel width to its default setting of 1600000 Hz.

Verifying Upstream Channel Width

To verify the current value of the upstream channel width, enter the **show controllers cable** command for the upstream port you just configured:

```
CMTS01# show controllers cable 6/0 u0
Cable6/0 Upstream 0 is up
  Frequency 24.016 MHz, Channel Width 0.800 MHz, QPSK Symbol Rate 0.640 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Use a valid combination of modulation format (QPSK/QAM-16), minislot size, frequency, and the **no shutdown** command.

- Use a recommended or previously tested modulation profile. It is not uncommon to create a modulation profile that does not allow cable modem-to-headend communication. Because each message type is individually specified, some messages may not work.
- Verify with IP ping packets of varying lengths (64 to 1500 bytes) by pinging from the headend to the cable modem.
- Verify with your cable modem vendor that the software is either fully qualified as DOCSIS-based or is verified for this modulation format.

Setting the Upstream Input Power Level

The Cisco uBR7200 series controls the output power levels of the cable modems to meet the desired upstream input power level. The nominal input power level for the upstream RF carrier is specified in decibels per millivolt (dBmV). The default setting of 0 dBmV is the optimal setting for the upstream power level.

The valid range for the input power level depends on the data rate. At 1.6 MHz, the valid range is –10 dBmV to 25 dBmV. If your power levels operate at greater than the maximum valid level, you must use an inline attenuator to bring the power level to within the valid range.

Caution If you increase the input power level, the cable modems on your HFC network will increase their transmit power level. A higher power level increases the CNR on the network but also increases distortion products. Composite Second Order Beat (CSO) and Composite Triple Beat (CTB) values worsen by 2 dB for every 1 dB of increased CNR. The return path laser immediately enters a nonlinear mode called clipping and all communication is no longer reliable. Many return lasers send short bursts well above the clipping thresholds and fail on longer or successive bursts.

You should not adjust your input power level by more than 5 dB in a 30-second interval. If you *increase* the power level by more than 5 dB within 30 seconds, cable modem service on your network will be disrupted. If you *decrease* the power level by more than 5 dB within 30 seconds, cable modems on your network will be forced offline.

Note We recommend that the adjacent channel not have a large variation when you enter the **cable upstream 0 power-level** command. The recommended maximum input power variance is 5 to 6 dBmV.

To set the upstream input power level, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `power-level` *dbmv*	Sets the upstream input power level. Enter the upstream power level in dBmV. Default = 0 dBmV.

Verifying the Upstream Input Power Level

To verify the current value of the upstream input power level, enter the **show controllers cable** command for the upstream port you have just configured:

```
CMTS01# show controllers cable 6/0 u0
Cable6/0 Upstream 0 is up
  Frequency 24.016 MHz, Channel Width 0.800 MHz, QPSK Symbol Rate 0.640 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Verify that the upstream amplitude of an optimal RF carrier injected at the fiber node reference input point reaches the MC16C input point at a consistent level (node-to-node and port-to-port), and that this absolute level as installed matches both the design and software settings on the Cisco uBR7200 series.
- Software adjustments of 1 to 3 dB can be used to adjust for minor variations in measurement or setup and port-to-port calibration differences. These adjustments can significantly improve cable modem performance, especially in marginal situations. Larger adjustments should be made in conjunction with spectrum analyzer-support in the headend.

Activating Upstream Admission Control

The admission control is set as a percentage of the specified upstream channel capacity. The acceptable range is from 10 to 1000 percent. Admission control is disabled by default.

To set the upstream admission control, use the following command in cable interface configuration mode:

Command	Purpose
CMTS01(config-if)# **cable upstream** *usport* **admission-control** *percentage*	Sets the admission control as a percentage of the upstream channel capacity. Valid range is from 10 to 1000 percent.

Verifying Upstream Admission Control

To verify whether or not upstream admission control has been configured and activated, enter the **show running-config** command in privileged EXEC mode and look for the cable interface configuration information. If upstream admission control has been configured and enabled, an admission control entry will be displayed in the **show running-config** output, indicating the user-defined percentage of upstream channel capacity allowable. If upstream admission control is disabled, no admission control entry will be displayed in the output.

```
CMTS01# show running-config
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating Upstream FEC

The Cisco uBR7200 series uses forward error correction (FEC) to attempt to correct any upstream data that might have been corrupted. FEC is activated by default and should not be disabled. When FEC is activated, all cable modems on the network also activate FEC.

Note Although upstream FEC is an option, we recommend that you always leave it activated.

To activate the upstream forward error correction, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `fec`	Enables FEC. This is the default setting.

Verifying Upstream FEC

To verify if FEC is activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If FEC is enabled, an FEC entry will be displayed in the **show running-config** output. If FEC is disabled, no FEC entry will be displayed in the output. The following is an excerpt from the **more system:running-config** command output.

```
router# more system:running-config
Building configuration...

!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Specifying Upstream Minislot Size

To specify the minislot size (in ticks) for specific upstream cable interfaces, use the following command in cable interface configuration mode:

Command	Purpose
CMTS01(config-if)# **cable upstream** *usport* **minislot-size** *size*	Specifies the minislot size in ticks for the selected upstream interface. Acceptable values are 2, 4, 8, 16, 32, 64, and 128. Default = 8.

Verifying Upstream Minislot Size

To verify upstream minislot size, enter the **show controllers cable 6/0 u0** command for the upstream port you have just configured:

```
CMTS01# show controllers cable 6/0 u0
Cable6/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
  part_id=0xFFFF, rev_id=0xFF, rev2_id=0xFF
  nb_agc_thr=0x0000, nb_agc_nom=0x0000
  Range Load Reg Size=0x58
  Request Load Reg Size=0x0E
  Minislot Size in number of Timebase Ticks is = 8
  Minislot Size in Symbols = 64
  Bandwidth Requests = 0xFE
  Piggyback Requests = 0xD
  Invalid BW Requests= 0x2
  Minislots Requested= 0x2963
  Minislots Granted  = 0x2963
  Minislot Size in Bytes = 16
  Map Advance = 4000 usecs
  UCD Count = 32964
  DES Ctrl Reg#0 = C000C043, Reg#1 = 0
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating the Upstream Scrambler

The scrambler on the upstream RF carrier enables cable modems on the HFC network to use built-in scrambler circuitry for upstream data transmissions. The scrambler circuitry improves reliability of the upstream receiver on the cable modem card. The upstream scrambler is activated by default and should not be disabled under normal circumstances.

Caution The upstream scrambler must be activated for normal operation. Disabling it can result in corrupted packets. Disable it only for prototype modems that do not support scrambler.

To activate the upstream scrambler after it has been disabled, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `scrambler`	Enables the scrambler. This is the default.

Verifying the Upstream Scrambler

To verify whether or not the upstream scrambler is activated, enter the **more system:running-config** command and look for the cable interface configuration information. The following is an excerpt from the **more system:running-config** command output:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating Upstream Differential Encoding

To enable differential encoding on upstream traffic to a specified cable interface, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `differential-encoding`	Enables differential encoding.

Upstream differential encoding is disabled by default.

Verifying Upstream Differential Encoding

To verify whether or not upstream differential encoding is activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream differential encoding is enabled, a differential encoding entry will be displayed in the **show running-config** output. If upstream differential encoding is disabled, no differential encoding entry will be displayed in the output.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating Upstream Rate Limiting

Upstream rate limiting allows upstream bandwidth requests from rate-exceeding cable modems to be buffered without incurring TCP-related timeouts and retransmits. The CMTS can thus enforce the peak upstream rate for each cable modem without degrading overall TCP performance for the subscriber CPE devices. Upstream grant shaping is per cable modem (SID).

Token bucket policing with shaping is the per-upstream default rate-limiting setting at the CMTS. Shaping can be enabled or disabled for the token bucket algorithm.

To enable upstream rate limiting for an upstream port on a Cisco cable modem card, use one of the following commands in cable interface configuration mode:

	Command	Purpose

Step 1	`CMTS01(config-if)# cable upstream` *usport* `rate-limit`
	
	or
	
	`CMTS01(config-if)# cable upstream` *usport* `rate-limit token-bucket`
	
	or
	
	`CMTS01(config-if)# cable upstream` *usport* `rate-limit token-bucket shaping`
		Enables rate limiting for the specified upstream cable interface.
		
		Enables rate limiting for the upstream cable interface employing the token bucket policing algorithm. With this command the Cisco uBR7200 series will automatically drop packets in violation of allowable upstream bandwidth.
		
		Default. Enables rate limiting for the upstream cable interface employing the token bucket policing algorithm with traffic shaping.

Step 2	`CMTS01(config-if)# ^Z CMTS01#`	Exits to EXEC mode so that you can verify upstream rate limiting.

To disable upstream traffic shaping for an upstream port, enter the following command in cable interface configuration mode:

`CMTS01(config-if)#` **`no cable upstream`** *usport* **`rate-limit`**

Verifying Upstream Rate Limiting

To verify whether or not upstream rate limiting has been configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream rate limiting has been configured and enabled, a rate limiting entry will be displayed in the **show running-config** output. If upstream rate limiting is disabled, `no cable upstream rate-limit` will be displayed in the output.

You can also perform the following tasks to verify that rate limiting is enabled on the upstream channel:

Step 1 Configure a low-peak upstream rate limit for the cable modem in its QoS profile. Either use the CLI to modify the QoS profile, or edit the TFTP configuration file.

Step 2 Use a regular rate-limiting algorithm on the upstream without rate shaping and see the drops of the excess bandwidth requests from this cable modem when it exceeds its peak upstream rate.

Use the **show interface cx/y sid counters** command to see the bandwidth request drops. See that the upstream rate received by that modem is in fact less than its configured peak rate due to the timeouts and backoffs produced by the drop in bandwidth requests. To see the input rate at the CMTS in bps, enter the **show interface cx/y sid** command.

Step 3 Enable grant shaping on the upstream channel by using the new **shaping** keyword extension to the token bucket algorithm CLI command.

Step 4 Make the cable modem exceed its peak upstream rate by generating heavy upstream traffic and see the effect of grant buffering (shaping) at the CMTS. If you use cable modem-to-CMTS pings, you will notice the pings slowing down.

Let the pings run for a few minutes (to let averages at CMTS settle); then see the upstream rate received by this single modem. Use the **show interface cx/y** command and observe the input rate in bps. This value should be close to the modem's peak upstream rate. Also observe the drop counts for the modem's SID by using the **show interface sid counters** command and see that CMTS no longer drops the bandwidth requests from the cable modem.

The bandwidth request drop count (from previous nonshaping test) remains unchanged when upstream rate shaping is used, indicating that the CMTS is actually shaping (buffering) the grants for the modem. See that the input rate at the CMTS (from the single rate-exceeded cable modem) stabilizes close to the configured peak rate of 128 kbps.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating Upstream Frequency Adjustment

To enable automatic upstream frequency adjustment for a specified cable interface, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `frequency-adjust averaging` *percentage*	Sets the minimum number of frequency adjustment packets required to justify changing the upstream frequency adjustment method as a percentage. Acceptable range is 10 to 100 percent. Default = 30 percent.

To return the automatic upstream frequency adjustment percentage to the default value of 30 percent, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport frequency-adjust averaging
```

Verifying Upstream Frequency Adjustment

To verify whether or not upstream frequency adjustment has been configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream frequency adjustment is enabled, frequency adjustment entries will be displayed in the **show running-config** output. If frequency adjustments have been disabled, no frequency adjustment entry will be displayed in the output.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating Upstream Power Adjustment

To enable upstream power adjustment for a specified cable interface, use the following commands in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable upstream` *usport* `power-adjust continue` *db*	Sets the minimum power adjustment in dB that will allow continued ranging status. Valid values are 2 to 15 dB. Default = 2 dB.
Step 2	`CMTS01(config-if)# cable upstream` *usport* `power-adjust noise` *percentage*	Sets the minimum number (percentage) of power adjustment packets required to justify changing the upstream power rating. Valid values are 10 to 100 percent. Default = 30 percent.
Step 3	`CMTS01(config-if)# cable upstream 0 power-adjust threshold` *db*	Sets the power adjustment threshold in dB. Valid values are 0 to 2 dB. Default = 1 dB.
Step 4	`CMTS01(config-if)# end CMTS01#`	Returns to enable (privileged EXEC) mode.

To return the automatic upstream power adjustment ranging value to the default of 2 dB, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport power-adjust continue
```

To return the automatic upstream power adjustment noise value to the default of 30 percent, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport power-adjust noise
```

To return the upstream power adjustment threshold value to the default of 1 dB, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport power-adjust threshold
```

Verifying Upstream Power Adjustment

To verify whether or not upstream power adjustment has been configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream power adjustment is enabled, any or all three of the **continue**, **noise**, and **threshold** power adjustment entries will be displayed in the **show running-config** output. If all three **continue**, **noise**, and **threshold** upstream power adjustments have been disabled, no power adjustment entry will be displayed in the **show running-config** output.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating Upstream Timing Adjustment

To enable upstream timing adjustment for a specified cable interface, use the following commands in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable upstream usport time-adjust continue seconds`	Sets the minimum timing adjustment that will allow continued ranging status. Valid values are 2 to 64 seconds. Default = 2 seconds.
Step 2	`CMTS01(config-if)# cable upstream usport time-adjust threshold seconds`	Sets the timing adjustment threshold value in seconds. Valid values are 1 to 32 seconds. Default = 1 second.
Step 3	`CMTS01(config-if)# end m CMTS01#`	Returns to enable (privileged EXEC) mode.

To return the upstream time adjustment ranging value to the default of 2 seconds, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport time-adjust continue
```

To return the upstream time adjustment threshold value to the default of 1 second, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport time-adjust threshold
```

Verifying Upstream Timing Adjustment

To verify whether or not upstream timing adjustment has been configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream timing adjustment is enabled, either or both of the **continue** and **threshold** timing adjustment entries will be displayed in the **show running-config** output. If both the **continue** and **threshold** upstream timing adjustments have been disabled, no timing adjustment entry will be displayed in the **show running-config** output.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Activating the Upstream Ports

Each upstream port must be activated to enable upstream data transmission from the cable modems on the HFC network to the Cisco uBR7200 series router.

Note The upstream cable interface will not operate until you either set a fixed upstream frequency or create and configure a spectrum group. See the "Setting the Upstream Frequency" or the "Configuring and Activating Frequency Agility" sections in this chapter for details.

To activate the upstream ports, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`CMTS01(config)# interface cable slot/port`	Specifies a cable interface and enters cable interface configuration mode.
Step 2	`CMTS01(config-if)# no cable upstream usport shutdown`	Enables upstream data traffic.

Verifying the Upstream Ports

To verify whether the upstream ports are activated or deactivated, enter the **show interface cable** command for the upstream port that you have just configured:

```
router# show interface cable 6/0
Cable6/0 is up, line protocol is up
 Hardware is BCM3210 FPGA, address is 00e0.1e5f.7a60 (bia 00e0.1e5f.7a60)
 Internet address is 1.1.1.3/24
 MTU 1500 bytes, BW 27000 Kbit, DLY 1000 usec, rely 255/255, load 1/255
 Encapsulation, loopback not set, keepalive not set
 ARP type: ARPA, ARP Timeout 04:00:00
 Last input 00:00:25, output 00:00:00, output hang never
 Last clearing of "show interface" counters never
 Queueing strategy: fifo
 Output queue 0/40, 0 drops; input queue 0/75, 0 drops
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Setting Upstream Backoff Values

The DOCSIS-specified method of contention resolution for cable modems wishing to transmit data or requests on the upstream channel is a truncated binary exponential backoff, with the initial backoff window and the maximum backoff window controlled by the CMTS. The Cisco uBR7200 series router specifies backoff window values for both data and initial ranging, and sends these values downstream as part of the Bandwidth Allocation Map (MAP) MAC message. The values are configurable on the Cisco uBR7200 series and are power-of-two values. For example, a value of 4 indicates a window from 0 to 15; a value of 10 indicates a window from 0 to 1023.

You can set fixed start and end values for data backoff on the upstream ports, or you can set the upstream ports for automatic data backoff. You have the same options for ranging backoff. For both backoff windows, the default start value is 0; the default end value is 4. Valid values are from 0 to 15.

To set data or ranging backoff values for an upstream port, use one or more of the following commands, beginning in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable upstream` *usport* `data-backoff` *start end* or `CMTS01(config-if)# cable upstream` *usport* `data-backoff automatic`	The **automatic** setting is optimized for up to 250 cable modems per upstream port. Set manual values for data backoff windows only when operating with more than 250 cable modems per upstream port. Configures the default backoff window values of 0 and 4.
Step 2	`CMTS01(config-if)# cable upstream` *usport* `range` *start end* or `CMTS01(config-if)# cable upstream` *usport* `range automatic`	The **automatic** setting is optimized for up to 250 cable modems per upstream port. Set manual values for ranging backoff windows only when operating with more than 250 cable modems per upstream port. Configures the default backoff window values of 0 and 4.

When considering whether or not to adjust backoff values, note the following:

- The cable modem reconnection time after a power outage is related to the following factors:
  - DHCP, TOD, and TFTP server capacity. These servers often operate well below 1 percent load under normal situations, but can jump to over 100 percent after an outage.
  - Adjusting the backoffs to larger numbers slows cable modem reconnection and reduces server load.
  - Backoffs that are too small result in cable modems failing to range the upstream RF levels correctly and cycling to maximum power, thus increasing connection time and reducing network performance.
  - Backoffs that are too large result in increased recovery time after a large service outage.
  - There is significant variation in cable modem performance (brand to brand) in cable modem restart time.
- All cable modems should recover in approximately 0 to 10 minutes after all services are restored (Cisco uBR7200 series, RF transport, DHCP/TFTP/TOD servers). If cable modems take longer than 10 minutes to recover, there could be a problem in the cable modem, in the headend settings, or in the DOCSIS provisioning servers.

Note Upstream segments serving a relatively large number of cable modems (for example, more than 1600 or so) may suffer recovery times longer than 10 minutes.

Verifying Upstream Data Backoff Automatic

To verify backoff window settings, enter the **show controllers cable 6/0 u0** command for the upstream port you have just configured:

```
CMTS01# show controllers cable 6/0 u0
Cable6/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
  part_id=0x3137, rev_id=0x03, rev2_id=0xFF
  nb_agc_thr=0x0000, nb_agc_nom=0x0000
  Range Load Reg Size=0x58
  Request Load Reg Size=0x0E
  Minislot Size in number of Timebase Ticks is = 8
  Minislot Size in Symbols = 64
  Bandwidth Requests = 0xFE
  Piggyback Requests = 0xD
  Invalid BW Requests= 0x2
  Minislots Requested= 0x2963
  Minislots Granted  = 0x2963
  Minislot Size in Bytes = 16
  Map Advance = 4000 usecs
  UCD Count = 32964
  DES Ctrl Reg#0 = C000C043, Reg#1 = 0
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure the cable connections are not loose or disconnected.
- Make sure the Cisco cable modem card is firmly seated in its chassis slot and the captive installation screws are tight.
- Make sure you entered the correct slot and port numbers when you typed the command.
- Make sure you entered the correct upstream port number:
  - On the MC16C cable modem card, this can be u0 to u5.
  - On the MC14C cable modem card, this can be u0 to u3.
  - On the MC12C cable modem card, this can be u0 or u1.
  - On the MC11C cable modem card, this can be u0 only.

Configuring and Activating Baseline Privacy

To encrypt upstream and downstream data, you need to configure and activate baseline privacy. Baseline privacy on an HFC network is configured with key encryption keys (KEKs) and traffic encryption keys (TEKs). The encryption is based on 40-bit or 56-bit data encryption standard (DES) encryption algorithms.

A KEK is assigned to a cable modem based on the cable modem SID and permits the cable modem to connect to the Cisco uBR7200 series when baseline privacy is activated. The TEK is assigned to a cable modem when its KEK has been established. The TEK is used to encrypt data traffic between the cable modem and the Cisco uBR7200 series.

KEKs and TEKs can be set to expire based on a grace-time or a life-time value. A grace-time key is used to assign a temporary key to a cable modem to access the network. A life-time key is used to assign a more permanent key to a cable modem. Each cable modem that has a life-time key assigned will request a new life-time key from the Cisco uBR7200 series before the current one expires.

Note Baseline privacy is only supported in Cisco IOS software containing "-k1" in the filename. If you do not already have a baseline privacy software image, you must download the software from Cisco Connection Online (CCO).

Note Baseline privacy will not operate unless the cable modem configuration file specifies that privacy is on.

The configuration and activation of baseline privacy depends on each cable operator physical plant.

To configure and activate baseline privacy, perform the following tasks:

- Configuring KEK Privacy
- Configuring TEK Privacy
- Activating Baseline Privacy

Configuring KEK Privacy

A grace-time KEK can be set from 300 to 1800 seconds. A life-time KEK can be set from 86,400 to 6,048,000 seconds. If you do not set a KEK value, the default values are used.

To configure KEK data privacy on the HFC network, use the following commands in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable privacy kek grace-time` *seconds*	Sets the cable privacy KEK grace time in seconds. Valid values are from 300 to 1800 seconds. Default = 600.
or	or
`CMTS01(config-if)# cable privacy kek life-time` *seconds*	Sets the cable privacy KEK life time in seconds. Valid values are from 86400 to 6048000 seconds. Default = 604800.

Verifying KEK Privacy

To verify the KEK life-time or grace-time values that have been set, enter the **show cable privacy kek** command:

```
CMTS01# show cable privacy kek
Configured KEK life time value = 750000
Configured KEK grace time value = 800
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you have entered a valid value for grace time or life time.

Configuring TEK Privacy

A grace-time TEK can be set from 300 to 1800 seconds. A life-time TEK can be set from 1800 to 604,800 seconds. If you do not set a TEK value, the defaults are used.

To configure TEK data privacy on the HFC network, use one of the following commands in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable privacy tek grace-time` *seconds* or `CMTS01(config-if)# cable privacy tek life-time` *seconds*	Sets the cable privacy TEK grace time in seconds. Valid values are from 300 to 1800 seconds. Default = 600. or Sets the cable privacy TEK life time in seconds. Valid values are from 1800 to 604800 seconds. Default = 43200.

Verifying TEK Privacy

To verify the TEK life-time or grace-time values that have been set, enter the **show cable privacy tek** command:

```
CMTS01# show cable privacy tek
Configured TEK life time value = 56000
Configured TEK grace time value = 900
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you have entered a valid value for grace time or life time.

Activating Baseline Privacy

After the KEK and TEK values have been set, activate encryption on the HFC network by using the following commands in cable interface configuration mode:

	Command	Purpose
Step 1	`CMTS01(config-if)# cable privacy enable`	Activates cable privacy. This is the default.
Step 2	`CMTS01(config-if)# cable privacy mandatory`	Activates cable privacy and does not allow access for any unencrypted cable modem connections.

Verifying Baseline Privacy

To verify whether or not baseline privacy is activated, enter the **cable privacy enable** or **cable privacy mandatory** command. By default, cable privacy is enabled and can only be disabled with the **no cable privacy** command.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered a valid value for grace time or life time for KEK and TEK privacy.
- If you entered the **cable privacy mandatory** command, then cable modems will not operate unless the cable modem configuration file specifies that privacy is on.

Configuring and Activating Frequency Agility

The Cisco uBR7200 series universal broadband routers divide a cable plant into downstream channels. Downstream channels contain upstream segments.

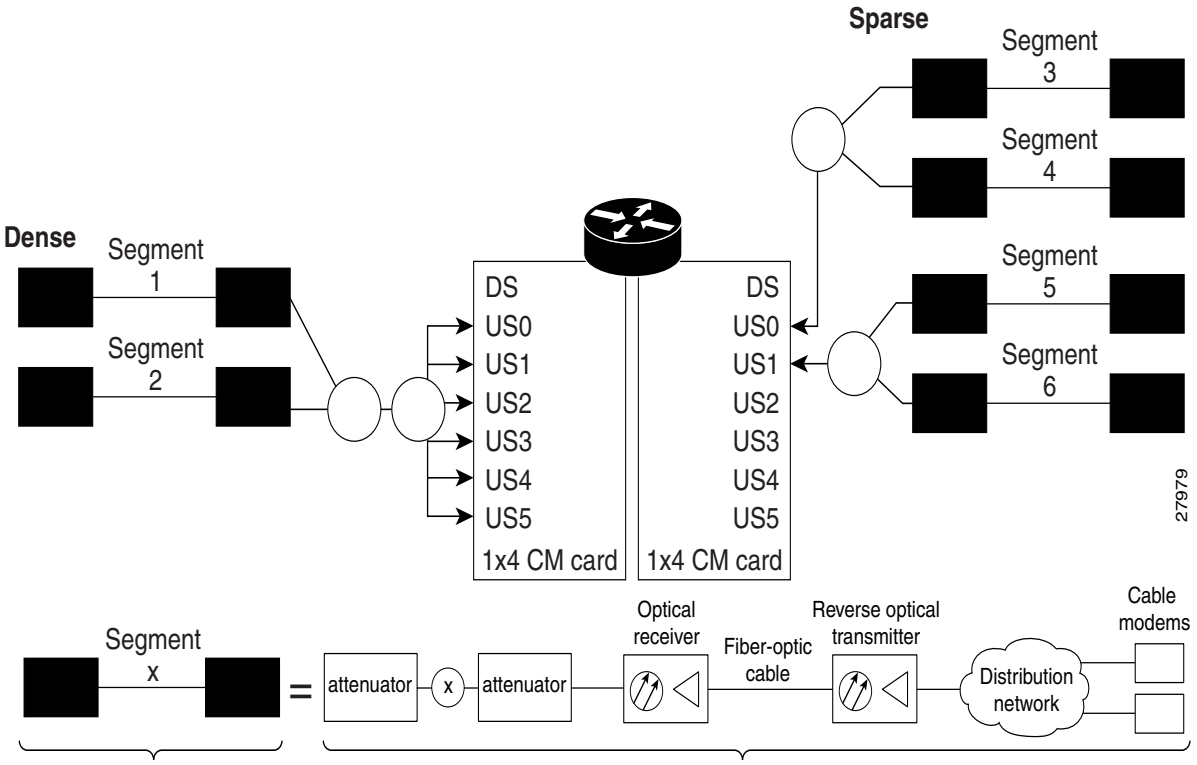
Each upstream segment typically serves more than one fiber node. Upstream segments can be defined as one of the following:

- Sparse segment—Containing one upstream channel per upstream segment.
- Dense segment—Containing multiple upstream channels per upstream segment; frequencies must be different.

Note A cable modem card supports either sparse or dense segments—not both.

Defining sparse segments allows the cable operator to share upstream bandwidth among fiber nodes with fewer subscribers. Defining dense segments allows the cable operator to provide larger upstream bandwidth to fiber nodes with many subscribers. Figure 109 illustrates sparse versus dense segments.

Figure 109 Sparse Versus Dense Segment Illustrations



As shown in Figure 109, the downstream segment can contain multiple upstream segments. Two fiber nodes can be in one downstream segment but in different upstream segments.

An upstream frequency has an associated upstream input power level in dBmV. Cable operators must make noise measurements and determine the cable plant spectrum management policy. Different modulation schemes and symbol rates can be used based on the characteristics of the cable plant and the cable modem card contained in the Cisco uBR7200 series chassis. Bits are encoded into a two-dimensional mapping called a constellation. A good carrier-to-noise ratio is needed to properly decode symbols into bits.

Combiner Groups

The return path of several fiber nodes can be combined at a single point to form a single RF frequency domain called a combiner group. The Cisco uBR7200 series software allows a frequency hop table called a spectrum group to be associated with a combiner group.

Note A combiner group refers to an RF topology point. A spectrum group refers to the frequency hop table associated with a combiner group.

The Cisco uBR7200 series routers support up to 32 spectrum groups. Each spectrum group defines the table of frequencies to be used in a specific frequency plan. Cisco cable modem cards interface the downstream and upstream ports to the cable plant, while port adapters connect to the IP backbone and external networks.

Frequency Management Policy

Upstream port frequency should be set to a fixed value during system installation and testing. This value is chosen from the allocation plan for the RF domain for the RF plant segment connected to the upstream.

Note Having fixed frequency settings is recommended during early deployment at least until amplifier cascade adjustments or plant repair becomes infrequent for the nodes connected to the upstream port. When multiple upstream ports are combined to provide increased bandwidth, care should be taken to prevent overlapping frequency bands.

When the system has reached sufficient stability, the RF domain topology can be entered into the Cisco IOS configuration file to enable RF spectrum management. This management feature—also called frequency agility—applies a common frequency management policy to a set of upstream ports.

Spectrum management or frequency agility is configured and activated using spectrum groups. A spectrum group is a frequency hop table that can be used by upstream ports to implement a frequency-hopping policy. There are four types of frequency-hopping policies: blind, scheduled, combined blind and scheduled, and guided.

Note When each upstream port has its own RF domain, the group is called a nonshared spectrum group. When multiple upstream ports share the same RF domain, the group is called a shared spectrum group.

Note The cable interface will not operate until you either create and configure a spectrum group or set a fixed upstream frequency. From the interface configuration prompt, an interface is assigned membership in a spectrum group. From the interface point of view, the spectrum group also represents the set of upstreams connected to the same group of fiber nodes. The spectrum manager is able to determine if upstream frequencies need to be managed together.

In general, when defining your spectrum use the following guidelines:

- Avoid frequencies with known ingress problems such as amateur radio bands or short-wave bands.
- Avoid hostile spectrum below 20 MHz.
- Allow extra bands for frequency hopping.
- Place upstream ports in the same combiner group in a shared spectrum group.
- Use the receive power level setting to perform slight equalization adjustments.

Frequency agility is configured and activated using spectrum groups that are controlled by the spectrum manager. You can create from 1 to 32 spectrum groups for each Cisco uBR7200 series cable modem card upstream port.

To configure and activate frequency agility, perform the tasks in the following sections:

- Determining the Upstream Ports Assigned to a Combiner Group
- Creating Spectrum Groups
- Configuring and Activating Spectrum Groups

- Configuring Spectrum Group Characteristics
- Assigning the Spectrum Group and the Upstream Ports

Determining the Upstream Ports Assigned to a Combiner Group

Following is an example topology for a Cisco uBR7223 with combiner groups designated A through J. Combiner groups C and E have multiple upstream ports that should be configured in a shared spectrum group. The other upstreams should be configured in a nonshared spectrum group.

In this example, ten combiner groups are served with frequency hop tables from three spectrum groups:

```
Cable3/0
DS +-----+ Upconverter +----- laser group 1
U0 +----- combiner group A
U1 +----- combiner group B
U2 +------combiner group C
U3 +------combiner group C
U4 +----- combiner group D
U5 +------combiner group E

Cable4/0
DS +-----+ Upconverter +----- laser group 2
U0 +------combiner group E
U1 +----- combiner group F
U2 +----- combiner group G
U3 +----- combiner group H
U4 +----- combiner group I
U5 +----- combiner group J
```

The laser group term refers to the set of fiber nodes that share the same downstream signal. An optical splitter is often used to create individual feeds per node.

In the downstream direction, two 6 MHz channel slots are assigned. All fiber nodes in combiner groups A through E should have a channel slot containing the downstream signal from Cable3/0. Combiner groups A through E are said to belong to laser group 1.

All fiber nodes in combiner groups E through J should have a channel slot containing the downstream signal from Cable4/0. Combiner groups E through J are said to belong to laser group 2.

Because combiner group E belongs to two laser groups, there should be two different downstream channel slots for Cable3/0 and Cable4/0.

Creating Spectrum Groups

To create a spectrum group, use one of the following commands in global configuration mode:

Command	Purpose
`CMTS01(config)# cable spectrum-group` *group-number* `type blind`	Creates a blind spectrum group.
or	
`CMTS01(config)# cable spectrum-group` *group-number* `type scheduled daily`	Creates a scheduled spectrum group that can change its frequency and power level at the same time every day.
or	
`CMTS01(config)# cable spectrum-group` *group-number* `type scheduled periodic-sec` *seconds*	Creates a scheduled spectrum group that can change its frequency and power level at a specified interval in seconds.

Verifying Spectrum Groups

To verify that a spectrum group has been created, enter the **show cable spectrum-group** command:

```
CMTS01# show cable spectrum-group
spectrum-group 1
spectrum-group 2
spectrum-group 3
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you have entered a valid spectrum group number and type.

Configuring and Activating Spectrum Groups

After you create a spectrum group, you need to configure a list of upstream frequencies and optional nominal power levels that each spectrum group can use when an upstream frequency change is necessary. Each spectrum group should have its own list of upstream frequencies. Valid frequencies are 5,000,000 to 42,000,000 Hz; valid power levels at a channel width of 1.6 MHz are –10 dBmV to 25 dBmV.

To configure and activate a spectrum group, use one of the following commands in global configuration mode:

Command	Purpose
`CMTS01(config)# cable spectrum-group` *group-number* [**time** *day hh:mm:ss*] [**delete**] **frequency** *ctr-freq-hz* [*power-level-dbmv*] or `CMTS01(config)# cable spectrum-group` *group-number* [**time** *day hh:mm:ss*] [**delete**] **band** *start-freq-hz end-freq-hz* [*power-level-dBmV*]	Adds the upstream frequency to the list of valid frequencies with a default power level for a spectrum group. **Note** If the time parameter is configured, the frequency setting or band is either made available or deleted at the specified time. The power level value should only be changed if you want to change the power level as part of spectrum management. The standard power level is 0 dBmV.

Note Configuring a spectrum group enables frequency agility and disables the fixed upstream frequency setting.

You must repeat the command described above for each frequency or power level that you want to add to a spectrum group's list of valid values.

If your cable plant has an upstream noise characteristic on a weekly cycle, use time-scheduled spectrum allocation. An example follows:

```
CMTS01(config)# cable spectrum-group 1 time Mon 08:00:00 frequency 21600000
```

Deletion is performed using the **delete** keyword:

```
CMTS01(config)# cable spectrum-group 1 time Mon 18:00:00 delete frequency 21600000
```

The following is an example of a spectrum group configuration that is designed to perform minor equalization as a function of frequency.

```
CMTS01(config)# cable spectrum-group 1 frequency 21600000
CMTS01(config)# cable spectrum-group 1 frequency 24800000 1
CMTS01(config)# cable spectrum-group 1 frequency 28000000 2
```

In this example, the upstream port nominal receive power at 21.6 MHz is 0 dBmV, at 24.8 MHz is 1 dBmV, and at 28.0 MHz is 2 dBmV. At any time, the power level set in the interface configuration overrides the spectrum group power level.

The following example enables spectrum management for all upstream ports, assuming that all combiner groups use the frequency band from 20 to 26 MHz:

```
CMTS01(config)# cable spectrum-group 1 band 20000000 26000000
CMTS01(config)# cable spectrum-group 2 shared
CMTS01(config)# cable spectrum-group 2 band 20000000 26000000
CMTS01(config)# cable spectrum-group 3 shared
CMTS01(config)# cable spectrum-group 3 band 20000000 26000000
CMTS01(config)# interface Cable3/0
CMTS01(config-if)# cable spectrum-group 1
CMTS01(config-if)# cable upstream 2 spectrum-group 2
CMTS01(config-if)# cable upstream 3 spectrum-group 2
CMTS01(config-if)# cable upstream 5 spectrum-group 3
CMTS01(config-if)# exit
CMTS01(config)# interface Cable4/0
CMTS01(config-if)# cable spectrum-group 1
CMTS01(config-if)# cable upstream 0 spectrum-group 3
```

A description of the spectrum groups 1 through 3 follows:

- Spectrum group 1—This group is nonshared. Upstream RF domains exist for each member upstream port.

```
Upstream Port   RF Domain
Cable3/0 U0     combiner group A
Cable3/0 U1     combiner group B
Cable3/0 U4     combiner group D
Cable4/0 U1     combiner group F
Cable4/0 U2     combiner group G
Cable4/0 U3     combiner group H
Cable4/0 U4     combiner group I
Cable4/0 U5     combiner group J
```

- Spectrum group 2—This group is shared. A single upstream RF domain exists.

```
Upstream Port   RF Domain
Cable3/0 U2     combiner group C
Cable3/0 U3     combiner group C
```

- Spectrum group 3—This group is shared. A single upstream RF domain exists.

```
Upstream Port   RF Domain
Cable3/0 U5     combiner group E
Cable4/0 U0     combiner group E
```

For the 20 to 26 MHz band of each RF domain, the spectrum is channelized according to the channel width settings of each member port. For example, if the ports U2 and U3 of Cable3/0 are set to 3.2 MHz and 1.6 MHz channel widths, respectively, then spectrum group 2 uses the following channelization:

```
> Channel Width Start Stop Center
>           (Mhz) (Mhz) (Mhz) (Mhz)
> 1         3.2    20.0 23.2 21.6
> 2*        1.6    20.0 21.6 20.8
> 3*        1.6    21.6 23.2 22.4
> 4         1.6    23.2 24.8 24.0
```

Note Channels 2 and 3 are not available when channel 1 is in use.

Because the group is shared, ports U2 and U3 will be assigned channels 1 and 4, respectively, to prevent overlap.

Note There are no alternate frequency assignments for either port and bandwidth is wasted from 24.8 to 26.0 MHz. To create alternate channels, increase the upper boundary from 26.0 to 28.0 MHz.

```
> Channel  Width  Start Stop  Center
>           (Mhz)  (Mhz) (Mhz) (Mhz)
>  1        3.2    20.0  23.2  21.6
>  2        3.2    23.2  26.4  24.8
>  3        1.6    20.0  21.6  20.8
>  4        1.6    21.6  23.2  22.4
>  5        1.6    23.2  24.8  24.0
>  6        1.6    24.8  26.4  25.6
>  7        1.6    26.4  28.0  27.4
```

Care should be taken to reduce the spectrum allocation when used with small channel widths. Otherwise, there will be a large number of upstream channel slots.

For example, if the allocation is from 20.0 to 28.0 MHz and an upstream port has its channel width set to 0.2 MHz, then there will be 40 possible slots for that channel width. Blind frequency hopping may require several minutes to find the clean slot because it will try each available slot, one at a time for several seconds each try.

Verifying Spectrum Group Configuration

To verify if spectrum groups have been configured and activated, enter the **show cable spectrum-group** command:

```
CMTS01# show cable spectrum-group
22:07:46: %SYS-5-CONFIG_I: Configured from console by console
Group  Frequency      Upstream     Weekly Scheduled             Power   Shared
No.    Band           Port         Availability                 Level   Spectrum
       (Mhz)                       From Time:    To Time:       (dBmV)
1       5.000-15.000                                            0       Yes
1      12.000                                                   0       Yes
1      22.000                                                   7       Yes
2      29.000                                                   6       No
2      26.000                                                   0       No
3      35.000-41.000                                            0       No
3      16.000-19.000                                            5       No
5*      5.000-10.000               Thu 21:50:00  Thu 21:45:00  0       Yes
```

Verifying Frequency Hopping

To verify frequency hopping on the Cisco uBR7200 series router, note the following:

- The controller must report being up.
- The comparison of the number of errors versus the number of error-free packets is a measure of the link quality. The percentage of errors should be less than 1percent.

After you have established basic operation, inject a tone to the upstream port. For example, if the upstream frequency is 22.4 MHz, inject a 22.4 MHz tone at approximately the same power level as the modem. (If the power level at the modem is 40 dBmV, set the tone power to 40 dBmV.) The interfering carrier should shut down the channel and cause the frequency to change to the next configured value. In this example, the next configured value is 24.0 MHz.

If you do not have an RF tone generator, use another line card and modem that carries traffic. Connect the upstream to the same combiner group, and use the data carrier as an interfering signal by setting it to the same frequency. For example, to test frequency hopping on c3/0, install c4/0 and connect both upstreams together using a combiner. If the upstream frequency of c3/0 is 22.4 MHz, set c4/0 to 22.4 MHz while c4/0 is carrying traffic. This should force c3/0 to change the frequency to the next configured value.

Troubleshooting Tips

To troubleshoot the configuration, make sure you entered a valid spectrum group number, time, frequency, and input power level. Also, when defining your spectrum, use the following guidelines:

- Avoid frequencies with known ingress problems such as amateur radio bands or short-wave bands.
- Avoid hostile spectrum below 20 MHz.
- Allow extra bands for frequency hopping.
- Place upstream ports in the same combiner group in a shared spectrum group.
- Use the receive power level setting to perform slight equalization adjustments.

Configuring Spectrum Group Characteristics

Once you have created spectrum groups for your cable network, you can add characteristics to them, providing you with more definitive control over frequency usage and frequency hopping.

As stated in Section 6.3.2.2 of the DOCSIS RFI specification, RF channel migration occurs by broadcasting a change in the upstream channel descriptor (UCD) message to all cable modems. The UCD message contains the upstream frequency and transmission parameters associated with an upstream channel.

The speed of channel migration via the UCD message is typically less than 20 ms. During this time, upstream transmission is interrupted until the cable modem transmitter adjusts to its new frequency. Data is stored in the cable modem buffers during this time and is sent when the frequency hop is complete.

Also, per the DOCSIS RFI, station maintenance intervals are used to perform per-modem “keepalive” polling. The Cisco uBR7200 series routers poll each cable modem at a default rate of once every 10 seconds. When ingress noise causes loss of keepalive messages from a configurable percentage of all cable modems, resulting in those cable modems going offline, a new frequency is selected from the allocation table and a UCD update is performed.

The migration time is 10 seconds (maximum) for the decision and 20 ms for the frequency hop. The percentage threshold method prevents a single failing cable modem from affecting service to other operational cable modems. The system will not hop endlessly because one cable modem is generating 90 percent of the errors and 90 percent of the traffic.

The minimum period between frequency hops is also configurable, with a default setting of 300 seconds. If the destination channel is expected to be impaired, the minimum period between frequency hops can be reduced to a small value such as 10 seconds. Reducing the time between frequency hops allows the frequency hop to continue more rapidly until a clear channel is found. If excessive frequency hop is a concern, the minimum period between hops can be increased.

To adjust the frequency hop threshold percentage or the minimum period between frequency hops, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`CMTS01(config)# cable spectrum-group` *groupnum* `hop threshold` *percent*	Sets the percentage of all cable modems losing keepalive messages (going offline) that will cause a frequency hop.
Step 2	`CMTS01(config)# cable spectrum-group` *groupnum* `hop period` *seconds*	Sets the minimum time between frequency hops in seconds. Valid values are from 1 to 3600 seconds.

The current implementation is known as blind frequency hop because there is no "look-ahead" mechanism. In this case, the search time is 0 seconds and the switching time is 20 ms.

To specify that a particular spectrum group is a shared RF spectrum group, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable spectrum-group` *groupnum* `shared`	Specifies a given spectrum group as "shared" and tells the Cisco uBR7200 series that you want to be sure that upstream frequencies assigned to upstream interfaces are not assigned to additional upstream interfaces.

Verifying Spectrum Group Characteristics

To verify spectrum group characteristics and whether or not a spectrum group is shared, enter the **show cable spectrum-group** command:

```
CMTS01# show cable spectrum-group
22:07:46: %SYS-5-CONFIG_I: Configured from console by console
Group  Frequency      Upstream     Weekly Scheduled            Power   Shared
No.    Band           Port         Availability                Level   Spectrum
       (Mhz)                       From Time:    To Time:      (dBmV)
1       5.000-15.000                                           0       Yes
1      12.000                                                  0       Yes
1      22.000                                                  7       Yes
2      29.000                                                  6       No
2      26.000                                                  0       No
3      35.000-41.000                                           0       No
3      16.000-19.000                                           5       No
5*      5.000-10.000               Thu 21:50:00  Thu 21:45:00  0       Yes
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered a valid spectrum group number and type.
- Make sure you are in global cable configuration mode.

Assigning the Spectrum Group and the Upstream Ports

To configure a frequency hop table after you have determined which upstream ports you want assigned to a combiner group, use the following commands:

	Command	Purpose
Step 1	`CMTS01(config)# interface cable slot/port`	Enters cable interface configuration mode for the interface to which you wish to assign a spectrum group.
Step 2	`CMTS01(config-if)# cable spectrum-group usport`	Assigns the spectrum group to the interface.
Step 3	`CMTS01(config-if)# cable upstream number spectrum-group usport`	Assigns the upstream ports to the spectrum group for the interface.
Step 4	`CMTS01(config-if)# no cable upstream slot/port shutdown`	Places the upstream port in the "admin up" state.

Step 5	`CMTS01(config-if)# exit`
	`CMTS01# test cable hop c3/0`
	`CMTS01# test cable hop c3/0`
		Exits configuration mode and forces the system to hop.

Verifying Spectrum Group and Upstream Port Assignments

To display the current allocation table and frequency assignments, use the **show cable spectrum-group** command.

Activating IP Address Resolution Protocol

Address Resolution Protocol (ARP) is an Internet protocol used to map IP addresses to MAC addresses on computers and other equipment installed in a network. You need to activate ARP requests on the cable interface so that the Cisco uBR7200 series can perform IP address resolution on the downstream path.

Note The default values for the commands used in this configuration step are adequate in most cases to configure the Cisco uBR7200 series.

Activating Cable ARP Requests

To activate ARP requests, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable arp`	Enables ARP. This is the default.

Verifying ARP Requests

To verify whether or not cable ARP has been activated, enter the **more system:running-config** command and look for the cable interface configuration information. If ARP has been activated, it does not appear in this output. If ARP has been deactivated, it will appear in the output as `no cable arp` as shown in this command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable arp
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you entered the correct port and cable modem card slot number when you activated ARP and when you entered the **show interface cable** command.

Activating Host-to-Host Communication (Proxy ARP)

Cable proxy ARP allows the Cisco uBR7200 series to issue cable ARP requests on behalf of cable modems on the same cable network subnet.

Note Because the downstream and upstreams are separate interfaces, modems cannot directly perform ARP with other modems on the cable plant.

Note The default values for the commands used in this configuration task are adequate in most cases to configure the Cisco uBR7200 series.

Activating Cable Proxy ARP Requests

To activate cable proxy ARP for host-to-host communications, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable proxy-arp`	Enables proxy ARP on the cable interface. This is the default.

Verifying Cable Proxy ARP Requests

To verify whether or not cable proxy ARP has been activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If cable proxy ARP has been activated, it does not appear in the output. If cable proxy ARP has been deactivated, it appears in the output as `no cable proxy-arp` as shown in this command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable proxy-arp
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you entered the correct port and cable modem card slot number when you activated cable proxy ARP.

Configuring DHCP Options

The following sections describe configurable DHCP options for the Cisco uBR7200 series.

Activating Cable Relay Agent

The cable relay agent is for use with DOCSIS-based DHCP servers that use option 87 to automatically map the Ethernet MAC address of a host (end user PC) with the cable modem to which it is connected.

With the cable relay agent activated, the Cisco uBR7200 series will insert the cable modem MAC address into a DHCP packet when a packet is received from a cable modem or another host. The Cisco uBR7200 series will then forward the packet to a DHCP server.

To activate the cable relay agent, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)#` **`cable relay-agent-option`**	Activates the cable relay agent. This is the default.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered the correct port and cable modem card slot number when you activated cable relay-agent-option.
- A DOCSIS-based DHCP server is required. The DHCP server verifies that the "fixed" IP address, if any, returned to the host is valid for the IP subnet on that downstream interface. The IP address must be unique and valid in the subnet for the end user to obtain connectivity.

Activating DHCP giaddr

Configure the Cisco uBR7200 series so it will either assign primary addresses to both cable modems and remote hosts, or assign primary addresses to cable modems and secondary addresses to remote hosts.

To configure cable DHCP giaddr functionality, use one of the following commands in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)#` **`cable dhcp-giaddr primary`** or `CMTS01(config-if)#` **`cable dhcp-giaddr policy`**	Enables cable DHCP giaddr functionality so that primary addresses are assigned to both cable modems and remote hosts. Enables cable DHCP giaddr functionality so that primary addresses are assigned to cable modems and secondary addresses are assigned to remote hosts.

To disable cable DHCP giaddr functionality (the default) after it has been enabled, enter the **no cable dhcp-giaddr** command in cable interface configuration mode.

Verifying DHCP giaddr Activation

To verify whether DHCP giaddr has been activated, enter the **show running-config** command and look for the cable interface configuration information. If DHCP giaddr has been activated, a notation will appear in this output. If DHCP giaddr has been deactivated, it will not appear in the output.

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered the correct port and cable modem card slot number when you activated DHCP giaddr.
- A DOCSIS-based DHCP server is required. The DHCP server verifies that the "fixed" IP address, if any, returned to the host is valid for the IP subnet on that downstream interface. The IP address must be unique and valid in the subnet for the end user to obtain connectivity.

Setting Service Options

The following sections describe configurable service options for the Cisco uBR7200 series.

Configuring ToD Service

To activate ToD service for the Cisco uBR7200 series, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable time-server enable`	Enables ToD service for the Cisco uBR7200 series.

To disable ToD service (the default) after it has been enabled, enter the **no cable time-server** command or the **cable time-server disable** command in global configuration mode.

Verifying ToD Service

To verify whether or not ToD service has been activated, enter the **show running-config** command and look for the global cable configuration information. If ToD service has been activated, an entry will appear in this output. If ToD service has been deactivated, no entry will appear in this output.

Troubleshooting Tips

To troubleshoot the configuration, make sure you are in global configuration mode.

Setting Optional IP Parameters

Additional IP parameters can be set to enable downstream echoing of upstream data. To configure these optional IP parameters, perform the tasks in the following sections:

- Activating IP Multicast Echo
- Activating IP Broadcast Echo

Note The default values for the commands used in these configuration steps are adequate in most cases to configure the Cisco uBR7200 series.

Activating IP Multicast Echo

The Cisco uBR7200 series echoes IP multicast packets by default. To activate IP multicast echo if it has been previously disabled, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable ip-multicast-echo`	Enables IP multicast echo. This is the default.

To disable IP multicast echo, enter the **no cable ip-multicast-echo** command in cable interface configuration mode.

Verifying IP Multicast Echo

To verify whether IP multicast echo has been activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If IP multicast echo is activated, there is no notation in the output as this is the default setting. If IP multicast echo has been deactivated, a notation appears in the output as shown in the following command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable ip-multicast-echo
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you entered the correct slot and port numbers when you entered cable interface configuration mode.

Activating IP Broadcast Echo

By default, the Cisco uBR7200 series does not echo IP broadcast packets. To activate IP broadcast echo, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable ip-broadcast-echo`	Enables IP broadcast echo.

To disable IP broadcast echo (the default setting), enter the **no cable ip-broadcast-echo** command in cable interface configuration mode.

Verifying IP Broadcast Echo

To verify whether IP broadcast echo has been activated or deactivated, enter the **more system:running-config** command and look for a notation in the cable interface configuration information as shown in the following command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable ip-broadcast-echo
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure that you entered the correct slot and port numbers when you entered cable interface configuration mode.

Configuring Cable Profiles

The following sections describe optional cable profile configuration tasks:

- Configuring Cable Modulation Profiles (Optional)
- Configuring QoS Profiles (Optional)
- Setting QoS Permission (Optional)
- Enforcing a QoS Profile Assignment (Optional)

Configuring Cable Modulation Profiles

This section describes how to define the elements that are used in a cable modulation profile. The Cisco uBR7200 series router supports up to eight cable modulation profiles. Profile 1 is the default.

Caution If you change a cable modulation profile, you also make changes to the physical layer. Changing physical layer characteristics affects router performance and function; therefore, this task should only be performed by an expert.

The following modulation profile values can be changed:

- Interval usage code (iuc)—Valid values are initial, long, reqdata, request, short, and station.
- Fec-tbytes—The number of bytes that can be corrected per FEC codeword. Valid range is 0 to 10 bytes, where 0 means no FEC.
- Fec-len—FEC codeword length. Valid range is 8 to 254 bits.
- Burst-len—Maximum burst length in bytes. A value of 0 means no limit on burst length.
- Guard-t—Guard time in symbols. This is the time between successive bursts.
- Mod—Modulation. Valid values are 16qam and qpsk.
- Scrambler—Enable or disable scrambler. Valid values are scrambler and no-scrambler.
- Seed—Scrambler seed in hexadecimal format. Valid range is 0x0000 to 0x7FFF.
- Diff—Enable or disable differential encoding. Valid values are diff and no-diff.
- Pre-len—Preamble length in bits. Valid range is 2 to 128 bits.
- Last-cw—Handling of FEC for last codeword. Valid values are fixed for fixed codeword length, and shortened for shortened last code word.
- Uw-len—Upstream unique word length. Enter uw8 for 8-bit unique words or uw16 for 16-bit unique code words.

To create or change a cable modulation profile, use the following command in global configuration mode:

Command	Purpose
CMTS01(config)# **cable modulation-profile** *profile iuc fec-tbytes fec-len burst-len guard-t mod scrambler seed diff pre-len last-cw uw-len*	Creates a new cable modulation profile with a profile number of *profile*, or modifies the existing profile having the number *profile*.

In the following example, the request burst for cable modulation profile 2 is defined to have 0 fec-tbytes, 16 KB fec-len, a burst-len of 1, a guard time of 8, a mod value of qpsk, scrambler enabled with a seed value of 152, differential encoding disabled, a preamble length of 64 bits, a fixed code-word length, and 8-bit unique words for upstream unique word length.

```
CMTS01(config)# cable modulation-profile 2 request 0 16 1 8 qpsk scrambler 152 no-diff 64
fixed uw8
```

To remove a cable modulation profile, use the **no cable modulation-profile** *profile* command in global configuration mode. You can use this command to remove all modulation profiles except for modulation profile 1. Entering the **no cable modulation-profile 1** command sets all of the parameters in profile 1 to the default values.

Verifying Cable Modulation Profiles

To verify whether or not a cable modulation profile has been created and to see how it is configured, enter the **show cable modulation-profile** command:

```
CMTS01# show cable modulation-profile
Mo IUC     Type  Preamb Diff FEC err FEC   Scrambl Max  Guard Last Scrambl Preamb
                 length enco correct T     seed    B    time  CW           offset
                                          bytes          size size   short
1  request qpsk  64     no   0x0     0x10  0x152   1    8     no   yes     56
1  initial qpsk  128    no   0x5     0x22  0x152   0    48    no   yes     0
1  station qpsk  128    no   0x5     0x22  0x152   0    48    no   yes     0
1  short   qpsk  72     no   0x5     0x4B  0x152   0    8     no   yes     48
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you are in global configuration mode.
- Make sure you typed the correct modulation profile number and profile elements when you used the command.
- Return to the default settings.

Configuring QoS Profiles

The Cisco uBR7200 series router supports multiple QoS profiles. QoS profile 1 is used during cable modem registration; QoS profile 2 is the default QoS profile. Both of these profiles are preconfigured and cannot be removed. However, you can modify these profiles and create additional QoS profiles for various traffic flows.

To create or change a QoS profile, use the first command in the following table, plus as many of the additional commands as are necessary to make the changes you require. All of the QoS profile commands are global configuration commands.

	Command	Purpose
Step 1	`CMTS01(config)# cable qos-profile` *groupnum*	Creates a new QoS profile with a profile number of *groupnum* , or modifies an existing profile.
Step 2	`CMTS01(config)# cable qos-profile` *groupnum* **ip-precedence** *bits*	Sets the bits in the ToS byte that enable you to configure individual data rate limits on a per-modem basis. Valid values are from 0 to 7.
Step 3	`CMTS01(config)# cable qos-profile` *groupnum* **guaranteed-upstream** *rate*	Sets the guaranteed minimum upstream rate in kbps. Valid values are from 0 to 100000 kbps. Default = 0 (no reserved rate).
Step 4	`CMTS01(config)# cable qos-profile` *groupnum* **max-burst** *size*	Sets the maximum upstream transmit burst size in bytes that the cable modem can send for any single transmit burst. Valid values are from 0 to 4080 bytes. Default = 0 (variable). Recommended max burst size = 1600.

	Command	Purpose
Step 5	`CMTS01(config)# cable qos-profile` *groupnum* **max-upstream** *rate*	Sets the maximum upstream data rate in kbps that a cable modem using this QoS profile will send. Valid values are from 0 to 100000 kbps. Default = 0 (no upstream rate limit.)
Step 6	`CMTS01(config)# cable qos-profile` *groupnum* **max-downstream** *rate*	Sets the maximum downstream data rate in kbps that a cable modem using this QoS profile will receive. Valid values are from 0 to 100000 kbps. Default = 0 (no downstream rate limit.)
Step 7	`CMTS01(config)# cable qos-profile` *groupnum* **priority** *number*	Assigns a relative priority number for the upstream traffic associated with this QoS profile. Valid values are from 0 to 7, with 7 being the highest priority. Default = 0.
Step 8	`CMTS01(config)# cable qos-profile` *groupnum* **tos-overwrite** *value*	Overwrites the ToS byte in the IP datagrams received on the upstream before forwarding them downstream. Sets the mask bits to a hexadecimal value to help the CMTS identify datagrams for QoS on the backbone.

Note You can use a single **cable qos-profile** command to configure multiple parameters for the selected QoS profile number.

Use the **no cable qos-profile** *groupnum* command to remove an optional QoS profile, or in the case of QoS profiles 1 and 2, to return the parameters to their default values.

Verifying QoS Profiles

To verify whether or not a QoS profile has been created, and to see how it is configured, enter the **show cable qos profile** command:

```
CMTS01# show cable qos profile
Service Prio Max       Guarantee Max        Max tx TOS  TOS   Create     B
class        upstream  upstream  downstream burst  mask value by         priv
             bandwidth bandwidth bandwidth                               enab
1       0    0         0         0          0      0x0  0x0   cmts       no
2       0    64000     0         1000000    0      0x0  0x0   cmts       no
3       0    1000      0         1000       0      0x0  0x0   cmts       no
4       7    2000000   100000    4000000    0      0x0  0x0   cm         yes
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you are in global configuration mode.
- Make sure you typed the correct QoS profile number and profile elements when you used the command.
- Note that cable modems that register continuously and fail consume more resources than cable modems that stay registered.
- Note that DOCSIS 1.0-certified cable modems that are given a short max-burst size may be unable to transmit large packets to the headend.

Setting QoS Permission

The Cisco uBR7200 series router supports the creation of QoS table entries by SNMP or by cable modem registration requests. You can also configure the Cisco uBR7200 series to dynamically update QoS table entries via SNMP.

To set QoS table access, use one or more of the following commands in global configuration mode:

	Command	Purpose
Step 1	`CMTS01(config)# cable qos permission create-snmp`	Enables SNMP access to create entries in the QoS tables.
Step 2	`CMTS01(config)# cable qos permission update-snmp`	Enables SNMP access to dynamically update entries in the QoS tables.
Step 3	`CMTS01(config)# cable qos permission modems`	Enables QoS table entries to be created via cable modem registration requests.
Step 4	`CMTS01(config)# no cable qos permission`	Disables both SNMP access and cable modem registration access to the QoS tables.

Verifying QoS Permission

To verify QoS permissions, enter the **show cable qos permission** command:

```
CMTS01# show cable qos permission
Create by SNMP  Update by SNMP  Create by modems
no              no              yes
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you are in global configuration mode.
- Make sure you typed the correct QoS profile number and profile elements.
- QoS profiles may be changed dynamically, permitting service tiers that are time-sensitive (more bandwidth during business hours than on weekends).

Enforcing a QoS Profile Assignment

To override the provisioned QoS profile of the cable modems connecting to the Cisco uBR7200 series and enforce a CMTS-specified QoS profile, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable qos permission enforce` *index*	Assigns the QoS profile, specified by the index number, to all cable modems attempting to connect to the Cisco uBR7200 series.

Verifying a QoS Profile Assignment

To verify a QoS profile assignment, perform the following steps:

Step 1 Load the Cisco uBR7200 series and wait for the cable modems to come online as indicated by the **show cable modem** command.

Notice that the modems are getting their provisioned class of service as indicated by the **show cable modem** and **show cable qos profile** commands.

Step 2 Configure any QoS profile at the CMTS with a specific index number (for example, index 1) by using the SNMP/CLI.

Step 3 Enter the **cable qos permission enforce 1** global configuration command.

Step 4 Enter the **clear cable modem all reset** global configuration command to force the modems to reregister with the CMTS.

Notice that the cable modems are assigned temporarily the CMTS-defined PRE_REGISTRATION QoS profile with index 2 until the cable modems register with the CMTS.

Step 5 Use the **debug cable reg** command to see that the provisioned QoS parameters of the modems are overwritten at the CMTS during registration.

Notice that at the end of the registration, the modem gets the user-enforced QoS profile as indicated by the **show cable modem** and **show cable qos profile** commands.

For additional information, refer to the **cable qos permission enforce** command reference page in the *Cisco IOS Multiservice Applications Command Reference*.

Managing Cable Modems on the HFC Network

You can manage the cable modems connected to the Cisco uBR7200 series on the HFC network by performing the optional tasks in the following sections:

- Configuring Sync Message Interval (Optional)
- Configuring Telco Return (Optional)
- Activating Cable Modem Authentication (Optional)
- Activating Cable Modem Upstream Address Verification (Optional)
- Activating Cable Modem Insertion Interval (Optional)
- Configuring the Maximum Number of Hosts Attached to a Cable Modem (Optional)
- Configuring Cable Modem Registration Timeout (Optional)
- Clearing and Resetting Cable Modems (Optional)
- Clearing Cable Modem Counters (Optional)
- Using Ping DOCSIS (Optional)

Note The default values for the commands used in these configuration steps are adequate in most cases to configure the Cisco uBR7200 series.

Configuring Sync Message Interval

To specify the interval between successive sync message transmissions from the Cisco uBR7200 series, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable sync-interval` *msec*	Specifies the interval in milliseconds (ms) between successive sync message transmissions from the Cisco uBR7200 series. Valid values are from 1 to 200 ms. Default = 10 ms.

To return the sync message interval to its default value of 10 ms, enter the **no cable sync-interval** command in cable interface configuration mode.

Verifying Sync Message Interval

To verify whether a sync message interval has been configured, enter the **show running-config** command and look for the cable interface configuration information. If a sync message interval has been configured, it will appear in this output. If the sync message interval has been deactivated or reset to its default value, no sync interval command line will appear in the output.

Troubleshooting Tips

To troubleshoot the configuration, make sure you entered the correct slot and port numbers when you entered cable interface configuration mode.

Configuring Telco Return

The Cisco uBR7200 series routers support both two-way communication and DOCSIS-based telco return communication from remote cable modems.

Note DOCSIS telco return is only supported in Cisco IOS software containing "t" in the filename. If you do not have a software image that supports telco return, you will need to download the software from CCO.

For detailed instructions on configuring telco return, refer to the document *Telephone Return for the Cisco uBR7200 Series Cable Router* on CCO. You will find this document on the index page for Cisco IOS software under the section "New Features for Cisco IOS Release 12.0(5)T."

Activating Cable Modem Authentication

The Cisco uBR7200 series can be configured to require all cable modems to return a known text string in order to register with the CMTS and gain access to the network. The text string can be from 1 to 80 characters in length.

To activate cable modem authentication, use the following command in cable interface configuration mode:

Command	Purpose
CMTS01(config-if)# **cable shared-secret** [**0** | **7**] *authentication-key*	Enables cable modem authentication. The number **0** specifies that an unencrypted authentication key follows; the number **7** specifies that an encrypted authentication key follows.

Verifying Cable Modem Authentication

To verify whether cable modem authentication has been activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If cable modem authentication has been activated, it does not appear in this output. If cable modem authentication has been deactivated, it appears in this output as `no cable secret-shared` as shown in this command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable secret-shared
 cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered the correct slot and port numbers when you entered cable interface configuration mode.
- Verify that the cable modem is using BPI and that it is assigned to a QoS with privacy active.
- Verify that the cable modem configuration file contains a matching key.

Note The DOCSIS configuration file editor cannot reread the key from a completed file because it would violate the security design.

Activating Cable Modem Upstream Address Verification

Cable modem upstream address verification ensures that only known cable modems that have received DHCP leases through the Cisco uBR7200 series can access the HFC network. The Cisco uBR7200 series will discard all packets received for or from hosts that have not received DHCP-assigned addresses.

To activate cable modem upstream address verification, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable source-verify [dhcp]`	Activates cable modem upstream verification. The **dhcp** option specifies that queries will be sent to verify unknown IP addresses in upstream data packets.

To deactivate cable modem upstream address verification (the default), enter the **no cable source-verify** command.

Verifying Cable Modem Upstream Address Verification

To verify whether cable modem upstream verification has been activated or deactivated, enter the **more system:running-config** command and look for a cable source-verify notation in the cable interface configuration information:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable source-verify
 cable insertion-interval 2000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered the correct slot and port numbers when you entered cable interface configuration mode.
- If the Cisco uBR7200 series is reloaded, or the ARP table is cleared, all hosts on the network will be forced to release and renew their IP addresses. Some systems may require restarting if the IP protocol stack is unable to renew using a broadcast IP address.
- Make sure BPI is active.

Activating Cable Modem Insertion Interval

When a cable modem is ready to join the HFC network and send data, it requests an upstream frequency from the Cisco uBR7200 series. You can limit the amount of time that a cable modem can request an upstream frequency from the Cisco uBR7200 series for the first time. The initial request of a cable

modem to join the network is known as initial ranging. The default insertion interval setting (**automatic**) configures the Cisco uBR7200 series to automatically vary the initial ranging times available to new cable modems that attempt to join the network.

Note Use the default setting if a large number of cable modems might attempt to perform initial ranging at the same time; for example, after a major power failure.

To configure the cable modem insertion interval, use one of the following commands in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable insertion-interval automatic` or	Configures the Cisco uBR7200 series to automatically vary the initial ranging times available to new cable modems that attempt to join the network.
`CMTS01(config-if)# cable insertion-interval min` *msec* or	Sets the minimum insertion interval in milliseconds (ms). Valid minimum range is from 25 to 200 ms. Default = 50 ms.
`CMTS01(config-if)# cable insertion-interval max` *msec*	Sets the maximum insertion interval in milliseconds. Valid maximum range is from 500 to 2000 ms. Default = 2000 ms.

To ignore any minimum or maximum insertion intervals and return to the automatic setting, enter the **no cable insertion-interval** command.

Verifying Cable Modem Insertion Interval

To verify that a cable modem insertion interval has been set, enter the **more system:running-config** command and look for a notation in the cable interface configuration information as shown in this command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable insertion-interval 2000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure that you entered the correct slot and port numbers when you typed the command.

Configuring the Maximum Number of Hosts Attached to a Cable Modem

To specify the maximum number of hosts that can be attached to a subscriber cable modem, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable max-hosts n`	Specifies the maximum number of hosts that can be attached to a cable modem on this interface. Valid range is from 0 to 255 hosts. Default = 0.

Verifying the Maximum Number of Hosts

To verify the maximum number of hosts that can be attached to a cable modem on a particular interface, enter the **more system:running-config** command and look for a notation in the cable interface configuration information as shown in this command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable insertion-interval 2000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure that you entered the correct slot and port numbers when you typed the command.

Configuring Cable Modem Registration Timeout

By default, registered cable modems that have no upstream activity for three minutes are timed out and disconnected from the Cisco uBR7200 series. This timeout interval can be decreased to two minutes or increased to 60 minutes.

To specify the registration timeout interval for cable modems connected to the Cisco uBR7200 series, use the following command in cable interface configuration mode:

Command	Purpose
CMTS01(config-if)# **cable registration-timeout** *n*	Specifies the maximum number of minutes that can elapse with no upstream activity before a cable modem is declared inactive and the connection terminated. Valid range is from 2 to 60 minutes. Default = 3 minutes.

Verifying Registration Timeout

To verify the registration timeout interval for a cable modem on a particular interface, enter the **more system:running-config** command and look for a notation in the cable interface configuration information as shown in this command output excerpt:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable6/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable insertion-interval 2000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
```

Troubleshooting Tips

To troubleshoot the configuration, make sure that you entered the correct slot and port numbers when you typed the command.

Clearing and Resetting Cable Modems

To remove a single cable modem (or all cable modems) from the Station Maintenance List and reset the cable modem (or all cable modems) on the network, use one of the following commands in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# clear cable modem` *mac-addr* **reset** or `CMTS01(config-if)# clear cable modem` *ip-addr* **reset** or `CMTS01(config-if)# clear cable modem all reset`	Removes the cable modem with a specific MAC address from the Station Maintenance List and resets it. Removes the cable modem with a specific IP address from the Station Maintenance List and resets it. Removes all cable modems from the Station Maintenance List and resets them.

Verifying Cable Modem Clearing and Resetting

To verify whether the **clear cable modem reset** command has removed a cable modem from the Station Maintenance List and forced it to start a reset sequence, enter the **show cable modem** command:

```
CMTS01# show cable modem 1.1.1.5
Interface US Online Timing SID  QoS IP address      MAC address
             State  Offset
```

Troubleshooting Tips

To troubleshoot the configuration, perform the following tasks:

- Make sure you entered the correct cable modem IP address or MAC address when you typed the command.
- This command is useful if an SNMP manager is not available, or if the cable modem is unable to obtain an IP address or respond to SNMP messages.

Note It might take up to 30 seconds for the cable modem to start the reset sequence.

Clearing Cable Modem Counters

To clear the counters for a cable modem (or for all cable modems) in the Station Maintenance List, use one of the following commands in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# clear cable modem` *mac-addr* **counters** or `CMTS01(config-if)# clear cable modem` *ip-addr* **counters** or `CMTS01(config-if)# clear cable modem all counters`	Clears the counters in the Station Maintenance List for the cable modem with a specific MAC address. Clears the counters in the Station Maintenance List for the cable modem with a specific IP address. Clears the counters in the Station Maintenance List for all cable modems.

Verifying that Cable Modem Counters are Cleared

To verify whether the counters in the Station Maintenance List have been cleared, enter the **show cable flap list** command. The station maintenance list counter will be 0.

```
CMTS01# show cable flap list
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you entered the correct cable modem MAC address or IP address when you typed the command.

Using Ping DOCSIS

To ping a specific cable modem to determine if it is online, use the following command in EXEC mode:

Command	Purpose
`CMTS01# ping docsis` *addr*	Ping the cable modem with a specific MAC address or IP address to see if it is online.

Verifying Ping DOCSIS

The output from the **ping docsis** command indicates whether or not the cable modem you were trying to contact was found on the network:

```
CMTS01# ping docsis 10.1.1.0
Queueing 5 MAC-layer station maintenance intervals, timeout is 25 msec:
!!!!!
Success rate is 100 percent (5/5)
```

Troubleshooting Tips

To troubleshoot the configuration, make sure you are using a valid MAC or IP address for the cable modem you want to ping.

Headend Broadband Access Router Configuration Examples

For most of the commands described in this document, the default values are adequate to configure the Cisco uBR7200 series router. To view the current configuration of a Cisco uBR7200 series, enter the **show running-config** command at the CLI prompt in EXEC mode or privileged EXEC mode.

Headend broadband access router configuration examples are provided in the following sections:

- Spectrum Management Configuration Example
- Virtual Private Network Configuration Example
- VoIP Configuration Example
- Telco Return Configuration Example
- QoS Profile Enforcement Configuration Example

Spectrum Management Configuration Example

In the following example, the Cisco uBR7200 series is configured to support spectrum management and modulation profiles.

```
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname uBR7246
!
boot system flash slot0:ubr7200-p-mz.120-4.T
boot system flash
!
cable spectrum-group 1 frequency 40000000
cable spectrum-group 1 frequency 20000000 2
cable modulation-profile 3 request 0 16 1 8 16qam scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 3 initial 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 3 station 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 3 short 5 75 6 8 16qam scrambler 152 no-diff 144 fixed uw8
cable modulation-profile 3 long 8 220 0 8 16qam scrambler 152 no-diff 160 fixed uw8
no cable qos permission create
no cable qos permission update
cable qos permission modems
ip subnet-zero
ip dhcp relay information option
!
interface FastEthernet0/0
ip address 10.1.70.2 255.255.255.0
no ip directed-broadcast
no ip mroute-cache
!
!
interface Ethernet2/3
ip address 1.3.59.1 255.255.0.0
no ip directed-broadcast
!
interface Cable5/0
ip address 172.1.71.1 255.255.255.0 secondary
ip address 10.1.71.1 255.255.252.0
no ip directed-broadcast
no ip route-cache
no ip mroute-cache
no keepalive
no cable proxy-arp
cable helper-address 10.1.70.30
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable upstream 0 spectrum-group 1
cable upstream 0 modulation-profile 3
cable downstream frequency 531000000
cable upstream 0 frequency 28000000
cable upstream 0 power-level 0
no cable upstream 0 shutdown
cable upstream 1 shutdown
cable upstream 2 shutdown
cable upstream 3 shutdown
cable upstream 4 shutdown
cable upstream 5 shutdown
```

```
!
!
router eigrp 100
network 10.0.0.0
!
ip classless
no ip http server
!
!
!
line con 0
password cisco
login
transport input none
line aux 0
line vty 0 4
password cisco
login
!
end
```

Virtual Private Network Configuration Example

VPN support enables you to offer private network connections to telecommuters and other business-oriented customers. In the following configuration example, a VPN is set up between two peer termination points: one at a remote cable modem and the other at a VPN gateway residing at a corporate office firewall. To properly transmit and receive encrypted/decrypted traffic, each peer in the VPN must activate encryption/decryption and have matching access key strings.

Note The Cisco uBR7200 series allows encrypted traffic to pass over the cable network (and often the Internet) from one peer to the other, based on a routing table setup in its configuration file. Following is a typical routing setup.

```
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname uBR7246
!
boot system flash slot0:ubr7200-k1p-mz_120-4_XI1
enable password ****
!
username smith privilege 15 password ****
cable flap-list aging 1
cable spectrum-group 1 band 20000000 26400000
cable spectrum-group 2 frequency 20000000
cable spectrum-group 2 frequency 20000000 2
cable spectrum-group 2 frequency 20000000 -2
cable spectrum-group 2 frequency 22000000
cable spectrum-group 2 frequency 22000000 2
cable spectrum-group 2 frequency 22000000 3
no cable qos permission create
no cable qos permission update
cable qos permission modems
```

```
ip subnet-zero
ip host abrick 223.255.254.254
!
!
!
interface FastEthernet0/0
 ip address 10.30.0.1 255.255.0.0
 no ip directed-broadcast
 full-duplex
 no cdp enable
!
interface FastEthernet1/0
 ip address 10.31.0.1 255.255.0.0
 ip helper-address 10.0.0.101
 no ip directed-broadcast
 full-duplex
 no cdp enable
!
interface Ethernet2/0
 ip address 10.32.0.1 255.255.0.0
 no ip directed-broadcast
 no cdp enable
!
interface Ethernet2/1
 no ip address
 no ip directed-broadcast
 shutdown
 no cdp enable
!
interface Ethernet2/2
 no ip address
 no ip directed-broadcast
 shutdown
 no cdp enable
!
interface Ethernet2/3
 no ip address
 no ip directed-broadcast
 shutdown
 no cdp enable
!
interface Cable3/0
 mac-address 1033.0000.1c30
 ip address 10.33.0.1 255.255.0.0
 no ip redirects
 no ip directed-broadcast
 ip helper-address 10.0.0.101
 load-interval 30
 no keepalive
 cable spectrum-group 1
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 453000000
 no cable upstream 0 shutdown
 cable upstream 1 frequency 18000000
 cable upstream 1 power-level 0
 no cable upstream 1 shutdown
 cable upstream 2 frequency 18000000
 cable upstream 2 power-level 0
 no cable upstream 2 shutdown
 cable upstream 3 frequency 18000000
 cable upstream 3 power-level 0
 no cable upstream 3 shutdown
```

```
 cable upstream 4 frequency 18000000
 cable upstream 4 power-level 0
 no cable upstream 4 shutdown
 cable upstream 5 frequency 18000000
 cable upstream 5 power-level 0
 no cable upstream 5 shutdown
!
interface Cable4/0
 no ip address
 no ip directed-broadcast
 no keepalive
 shutdown
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 cable upstream 4 shutdown
 cable upstream 5 shutdown
!
ip classless
ip route 0.0.0.0 0.0.0.0 10.30.0.10
ip route 10.51.0.0 255.255.0.0 10.32.0.10
ip route 10.100.1.0 255.255.255.248 10.33.1.10
ip flow-export destination 10.32.0.8 9995
ip http server
ip http authentication local
!
no cdp run
snmp-server engineID local 00000090200000905F0E7800
snmp-server community public RW
!
tftp-server flash slot0:basic.cfg
tftp-server flash slot0:boot.tft
tftp-server flash slot0:bootmin.tftp
alias exec shcm show cable modem
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 1
 exec-timeout 0 0
 password lab
 login
 length 0
line vty 2
 exec-timeout 0 0
 password lab
 login
line vty 3
 exec-timeout 0 0
 password lab
 login
 length 0
line vty 4
 exec-timeout 0 0
 password lab
 login
!
end
```

VoIP Configuration Example

Following is a sample VoIP configuration file for a Cisco uBR7200 series cable router:

Caution In certain countries, the provisioning of voice telephony over the Internet may be prohibited or subject to laws, regulations, or licenses, including requirements applicable to the use of the products under telecommunications and other laws and regulations; you must comply with all such applicable laws in the country or countries where you intend to use the product.

```
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname twoslot
!
enable password ****
!
cable modulation-profile 2 request 0 16 1 8 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 2 initial 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 2 station 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 2 short 6 75 6 8 16qam scrambler 152 no-diff 144 fixed uw8
cable modulation-profile 2 long 8 220 0 8 16qam scrambler 152 no-diff 160 fixed uw8
cable modulation-profile 3 initial 5 34 0 48 16qam scrambler 152 no-diff 128 shortened
uw16
cable modulation-profile 3 station 5 34 0 48 16qam scrambler 152 no-diff 128 shortened
uw16
cable modulation-profile 3 short 5 75 6 8 16qam scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 3 long 8 220 0 8 16qam scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 4 request 0 16 1 8 qpsk scrambler 152 no-diff 64 shortened uw16
cable modulation-profile 4 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 shortened uw16
cable modulation-profile 4 station 5 34 0 48 qpsk scrambler 152 no-diff 128 shortened uw16
cable modulation-profile 4 short 5 75 6 8 qpsk scrambler 152 no-diff 72 shortened uw8
cable modulation-profile 4 long 8 220 0 8 qpsk scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 5 request 0 16 2 8 qpsk scrambler 152 no-diff 64 fixeduw8
cable modulation-profile 5 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 5 short 5 78 8 8 16qam scrambler 152 no-diff 144 shortened uw8
cable modulation-profile 5 long 10 235 8 8 16qam scrambler 152 no-diff 160 shortened uw8
cable modulation-profile 6 request 0 16 1 8 16qam scrambler 152 no-diff 128 shortened uw16
cable modulation-profile 6 initial 5 34 0 48 16qam scrambler 152 no-diff 256 shortened w16
cable modulation-profile 6 station 5 34 0 48 16qam scrambler 152 no-diff 256 shortened
uw16
cable modulation-profile 6 short 6 75 6 8 16qam scrambler 152 no-diff 144 shortened uw8
cable modulation-profile 6 long 8 220 0 8 16qam scrambler 152 no-diff 160 shortened uw8
cable modulation-profile 7 request 0 16 1 8 16qam scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 7 initial 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 7 station 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 7 short 6 75 6 8 16qam scrambler 152 no-diff 144 fixed uw8
cable modulation-profile 7 long 8 220 0 8 16qam scrambler 152 no-diff 160 fixed uw8
cable modulation-profile 8 request 0 16 1 8 qpsk scrambler 152 no-diff 64 fixed uw8
cable modulation-profile 8 initial 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 8 station 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 8 short 6 75 6 8 16qam scrambler 152 no-diff 144 fixed uw8
cable modulation-profile 8 long 8 220 0 8 16qam scrambler 152 no-diff 160 fixed uw8
no cable qos permission create
no cable qos permission update
cable qos permission modems
!
```

```
!
!
!
ip subnet-zero
no ip domain-lookup
ip host abrick 223.255.254.254
ip host muck 255.255.255.255
ip host keyer 223.255.254.254
ip host bell 223.255.254.253
!
!
!
interface FastEthernet0/0
ip address 2.2.2.2 255.255.255.0
no ip directed-broadcast
no ip mroute-cache
shutdown
!
interface Ethernet1/0
ip address 1.11.8.1 255.255.0.0
ip broadcast-address 1.11.255.255
ip helper-address 223.255.254.254
no ip directed-broadcast
no ip mroute-cache
!
interface Ethernet1/1
ip address 10.20.122.2 255.255.255.192
ip helper-address 10.0.0.2
no ip directed-broadcast
!
interface Ethernet1/2
no ip address
no ip directed-broadcast
shutdown
!
interface Ethernet1/3
no ip address
no ip directed-broadcast
shutdown
!
interface Cable2/0
ip address 20.20.20.20 255.255.255.0
no ip directed-broadcast
no keepalive
cable downstream modulation 64qam
cable upstream 0 frequency 10000000
cable upstream 0 power-level 0
no cable upstream 0 shutdown
cable upstream 1 frequency 10000000
cable upstream 1 power-level 0
no cable upstream 1 shutdown
cable upstream 2 shutdown
cable upstream 3 shutdown
cable upstream 4 shutdown
cable upstream 5 shutdown
!
ip default-gateway 1.11.0.1
ip classless
ip route 0.0.0.0 0.0.0.0 10.20.122.1
ip route 223.255.254.254 255.255.255.255 1.11.0.1
ip http server
!
!
tftp-server flash slot1:ubr920-y5-mz.euro alias ubr900
```

```
!
!
line con 0
exec-timeout 0 0
transport input none
line aux 0
line vty 0 4
login
line vty 5 11
login
!
end
```

Telco Return Configuration Example

Following is a sample configuration file displaying critical elements of a telco return network configuration for the Cisco uBR7200 series, including the following:

- AAA configuration
- Telco return-specific configuration
- SNMP server-specific configuration
- RADIUS dial server-specific information

Note Some telco return cable modems cannot receive traffic over the same downstream channel as cable modems operating on a two-way data system. In a cable network where you plan to service both telco return and two-way cable modems, you may need to segment your cable headend to allow more than one downstream channel.

```
version 12.1
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname uBR7246
!
boot system flash slot0:ubr7200-p-mz.**********
boot system flash
logging buffered 100000 debugging
aaa new-model
aaa authentication login default radius enable
aaa authentication login vty line
aaa accounting update newinfo
aaa accounting exec default start-stop radius
aaa accounting commands 15 default start-stop radius
aaa accounting network default start-stop radius
aaa accounting system default start-stop radius
enable secret guess_my_password_ha_ha_ha.
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
ip subnet-zero
no ip finger
no ip domain-lookup
!
!
interface Loopback0
```

```
ip address 24.1.2.246 255.255.255.0
no ip directed-broadcast
!
interface FastEthernet0/0
no ip address
no ip directed-broadcast
shutdown
media-type MII
full-duplex
!
interface Hssi1/0
ip unnumbered Loopback0
no ip directed-broadcast
!
interface Cable3/0
ip address 10.1.1.1 255.255.255.0
no ip directed-broadcast
ip helper-address 24.1.1.84
no keepalive
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 687000000
cable upstream 0 frequency 13008000
no cable upstream 0 shutdown
cable upstream 1 shutdown
cable upstream 2 shutdown
cable upstream 3 shutdown
cable upstream 4 shutdown
cable upstream 5 shutdown
!
interface Cable6/0
ip address 172.16.1.1 secondary
ip address 10.1.1.1
no ip directed-broadcast
ip helper-address 24.1.1.84
no keepalive
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 687000000
cable upstream 0 frequency 13008000
no cable upstream 0 shutdown
cable telco-return enable
cable telco-return spd 1 factory-default
cable telco-return spd 1 dhcp-authenticate
cable telco-return spd 1 dhcp-server 24.1.1.84
cable telco-return spd 1 ppp-authenticate chap
cable telco-return spd 1 phonenum 918005555555
cable telco-return spd 1 phonenum 18005555555
cable telco-return spd 1 username test
cable telco-return spd 1 password test
!
router ospf 100
network 10.0.0.0 0.255.255.255 area 0
network 24.1.0.0 0.0.255.255 area 0
!
ip classless
ip route 0.0.0.0 0.0.0.0 24.1.2.21
!
logging 24.1.1.78
snmp-server community public RO
snmp-server community favorite_server_community RW
snmp-server location favorite_location
```

```
!
radius-server host 24.1.1.78 auth-port 1645 acct-port 1646
radius-server key radius_server_key
!
line con 0
password No need to change; this is encrypted already.
transport input none
flowcontrol software
line aux 0
password No need to change; this is encrypted already.
flowcontrol hardware
line vty 0 4
password No need to change; this is encrypted already.
login authentication vty
end
```

QoS Profile Enforcement Configuration Example

The following example shows how a cable modem with a QoS profile of 4, created by the cable modem (*cm*), is reset to use QoS profile 225 enforced by the Cisco uBR7200 series (*management*):

```
CMTS01# show cable modem
 Interface    SID   Online     Timing Receive QoS IP address      MAC
 address
                    State      Offset Power
 Cable6/0/U0  1     online     2848    0.00   4   19.2.20.139 0010.7b6b.7215

 CMTS01# show cable qos profile 4
 Service Prio Max       Guarantee Max        Max tx TOS  TOS   Create  B
 class        upstream  upstream  downstream burst  mask value by      priv
              bandwidth bandwidth bandwidth                           enab
 4       7    128000    64000     2048000    255    0x0  0x0   cm      no


CMTS01(config)# cable qos profile 225 max-upstream 256
CMTS01(config)# cable qos permission enforce 225
CMTS01# clear cable modem all reset
CMTS01# show cable modem
 Interface    SID   Online     Timing Receive QoS IP address      MACaddress
                    State      Offset Power
 Cable6/0/U0  1     offline    2848    0.25   2   19.2.20.139 0010.7b6b.7215

CMTS01# debug cable reg
 ....
 00:15:59: Finished parsing REG Request
 00:15:59: Overriding Provisioned QoS Parameters In REG-REQ
 ....

CMTS01# show cable modem
 Interface    SID   Online     Timing Receive QoS IP address      MACaddress
                    State      Offset Power
 Cable6/0/U0  1     online     2852    0.00   225 19.2.20.139  0010.7b6b.7215

 CMTS01# show cable qos profile 225
 Service Prio Max       Guarantee Max        Max tx TOS  TOS   Create     B
 class        upstream  upstream  downstream burst  mask value by         priv
              bandwidth bandwidth bandwidth                              enab
 225     0    256000    0         0          0      0x0  0x0   management no
```

Troubleshooting Using Cable Flap Lists

A cable flap list is a table maintained by the Cisco uBR7200 series for every cable modem (active or not active) that is having difficulties communicating with the headend. Flapping refers to the rapid disconnecting and reconnecting of a cable modem. The flap list contains cable modem MAC addresses and logs the time of the most recent activity. You can configure the size, recording duration, and entry thresholds for the flap list.

The following tips and scenarios allow you to use the flap list in the most effective way:

- If a subscriber cable modem shows substantial flap list activity, it is having communication problems.
- If a subscriber's cable modem shows little or no flap list activity, it is communicating reliably; the problem is probably in the subscriber computer equipment or in the connection to the cable modem.
- The top 10 percent most active cable modems in the flap list are most likely to have difficulties communicating with the headend.
- Cable modems with more than 50 power adjustments per day have a suspect upstream path.
- Cable modems with approximately the same number of hits and misses and with many insertions have a suspect downstream path (for example, low level into the cable modem).
- All cable modems incrementing the insertion at the same time indicates a provisioning server failure.
- Cable modems with a high number of CRC errors have unstable upstream paths or in-home wiring problems.
- Correlating cable modems on the same physical upstream port with similar flap list statistics can quickly isolate outside plant problems to a particular node or geography.
- Monitoring the flap list cannot affect cable modem communications.
- The flap list should be "dumped" to a database computer and cleared at least once a day.
- Important upstream performance data can be obtained by tracking flap list trend data.
- Important installation quality control and performance data is directly available from the flap list.

Setting Cable Flap List Aging

You can specify the number of days to record and retain flapping activity on cable modems currently in the flap list table. This value is known as the age of the flap list. The valid range is from 1 to 60 days.

To set the age of the flap list, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable flap-list aging` *days*	Specifies the number of days to record and retain flapping activity for the cable modems connected to this Cisco uBR7200 series router.

Verifying Cable Flap List Aging

To verify that cable flap list aging is set, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit    Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C3/0 U0      0    688     169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C3/0 U0      1    707     185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C3/0 U0      1    707     198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C3/0 U0      1    709     205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C3/0 U0      1    710     204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Insertion Time

You can set the cable flap list insertion time. When a cable modem makes an insertion request more frequently than the amount of insertion time defined by this command, the cable modem is placed in the flap list for activity recording. The valid range is from 60 to 86400 seconds.

To set the cable flap list insertion time, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable flap-list insertion-time` *seconds*	Specifies the insertion time in seconds. Any cable modem that makes an insertion request more frequently than this period of time is placed in the flap list.

Verifying Cable Flap List Insertion Time

To verify cable flap list insertion time, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit    Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C3/0 U0      0    688     169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C3/0 U0      1    707     185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C3/0 U0      1    707     198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C3/0 U0      1    709     205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C3/0 U0      1    710     204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Power Adjustment Threshold

You can specify the power adjustment threshold that will cause a flap list event to be recorded. When the power adjustment of a cable modem meets or exceeds the threshold, the cable modem is placed in the flap list. The valid range is from 1 to 10 dBmV.

Note A power adjustment threshold of less than 2 dBmV might cause excessive flap list event recording. We recommend setting this threshold value to 3 dBmV or higher.

To set the power adjustment threshold for flap list events, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable flap-list power-adjust threshold` *dbmv*	Specifies the minimum power adjustment that will constitute a flap list event.

Verifying Cable Flap List Power Adjustment Threshold

To verify the cable flap list power adjustment threshold, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit    Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C3/0 U0      0    688     169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C3/0 U0      1    707     185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C3/0 U0      1    707     198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C3/0 U0      1    709     205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C3/0 U0      1    710     204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Miss Threshold

You can specify the miss threshold for recording a flap list event. A miss is the number of times a cable modem does not acknowledge a MAC-layer keepalive message from a cable modem card. An 8 percent miss rate is normal for the Cisco cable modem cards. When the number of misses exceeds the threshold, the cable modem is placed in the flap list.

Note A high miss rate can indicate intermittent upstream problems, fiber laser clipping, or common-path distortion.

To set the miss threshold for recording a flap list event, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable flap-list miss-threshold` *misses*	Specifies the number of MAC-layer keepalive misses that will result in the cable modems being place in the flap list.

Verifying Cable Flap List Miss Threshold

To verify the cable flap list miss threshold, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit    Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C3/0 U0      0    688     169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C3/0 U0      1    707     185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C3/0 U0      1    707     198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C3/0 U0      1    709     205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C3/0 U0      1    710     204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Size

You can specify the maximum number of cable modems that can be listed in the cable flap list tables. The valid range is from 1 to 8192 cable modems. The default is 8192 cable modems.

To specify the maximum number of cable modems that can be recorded in the flap list, use the following command in global configuration mode:

Command	Purpose
`CMTS01(config)# cable flap-list size number`	Specifies the maximum size of the flap list.

Verifying Cable Flap List Size

To verify the cable flap list size, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit    Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C3/0 U0      0    688     169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C3/0 U0      1    707     185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C3/0 U0      1    707     198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C3/0 U0      1    709     205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C3/0 U0      1    710     204      0      0      7 Nov 5  12:30:16
```

Clearing Cable Flap List

To remove a single cable modem from the flap list or to remove all cable modems from the flap list, use one of the following commands in global configuration mode:

Command	Purpose
`CMTS01(config)# clear cable flap-list mac-addr`	Clears the entries in the cable flap list for the cable modem with this MAC address.
or	
`CMTS01(config)# clear cable flap-list all`	Clears the entries for all of the cable modems in the flap list.